HESIS GUIDE TO SOLVENT SAFETY

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May, 1997

HESIS GUIDE TO SOLVENT SAFETY

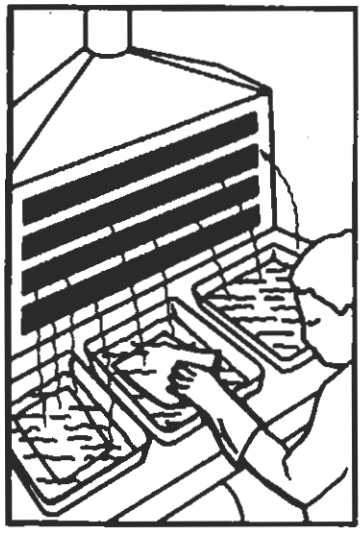
What Happened to Bill (or, why you should read this handbook)

"BILL IS OUR DIESEL MECHANIC. He got tired of having stains on his hands so he started washing with shop solvent. It worked pretty well! Next thing we knew, he couldn't work for two weeks because of some skin disease on his hands."

"DOLORES WAS CLEANING OUT THE TANKS when she passed out from the solvent fumes. Phil went in to rescue her, but he lost consciousness too. By the time the Fire Department got them out, Dolores had stopped breathing. Both of them have brain damage, and the docs don't know if Dolores can ever work again..."

"LISTEN, I'VE BEEN USING THIS PAINT STRIPPER for 25 years. It's never bothered me, and no one made a big deal about it. So what's this here on the safety sheet about methylene chloride affecting people with heart disease?"

Contents



Part Two: Managing Solvent Health and Safety

Part Three: Reference Section

How to use this guide

PART ONE IS FOR ON-THE-JOB USE
Part One answers questions most often asked by solvent users, and explains safe work practices.

PART TWO IS ABOUT MANAGING SOLVENT HEALTH AND SAFETY
Setting up a solvent operation is different from working in one. Part Two explains how to supply the solvent worker with the right materials, equipment, and training needed to prevent health and safety problems. It discusses the responsibilities of employers. You may copy any pages you wish to use for training handouts, posting, or your Injury and Illness Prevention Plan.

IN THE BACK OF THE BOOKLET
You will find a list of resources for further information for workers and employers, a list of other HESIS publications you can order, and a table where you can look up common industrial solvents. First Aid instructions for solvent accidents are on the back cover.

PART ONE:
SOLVENT HEALTH AND SAFETY ON THE JOB

What are solvents?

Solvents are liquids or gases that can dissolve other substances.

YOU WILL FIND SOLVENTS:

- in paints, inks and other coatings
- as cleaners and degreasers
- in paint strippers
- in glues and spray products
- as refrigerants and coolants
- in thousands of other products at work and at home.

ORGANIC SOLVENTS ARE TOXIC

They can harm your health if they get into your body. Some are highly toxic, meaning that a small amount can harm you. Others are not very toxic, so it takes a larger amount to cause harm. We say you are **overexposed** to a solvent if you absorb an amount that is likely to harm you.

In this booklet, we use the word "solvents" to mean organic solvents only. Organic solvents are those that have carbon in their chemical structure.

Here are some common solvents in the workplace:

Thinners and mixtures:
paint thinners
petroleum distillates
naphtha
white spirits
mineral spirits
lacquer thinners

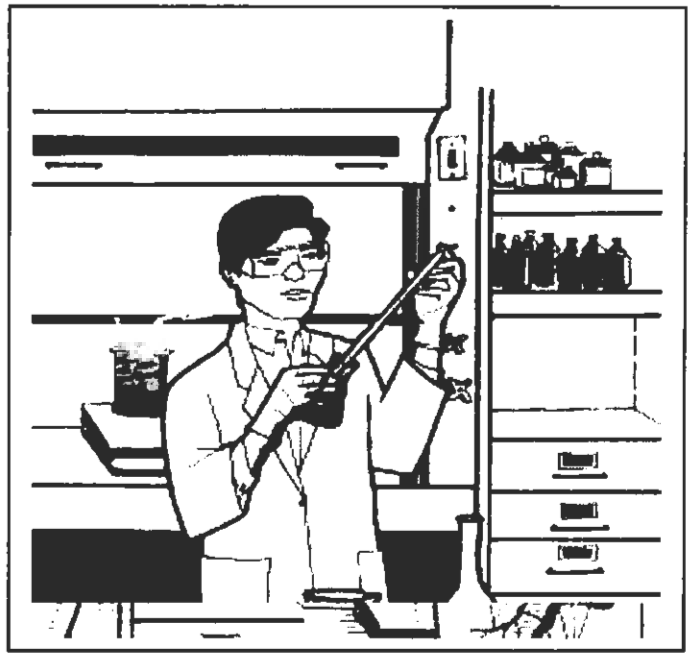
Chlorinated solvents:
chloroform
fluorocarbons and chlorofluorocarbons (Freons® or CFC's)
methylene chloride
perchloroethylene ("perc")
TCA (1,1,1-trichloroethane)
TCE (trichloroethylene)

Fuels:
diesel
gasoline
jet fuels

Aromatic solvents:
styrene
benzene
toluene
xylene

Glycol ethers
Carbitols
Cellosolves
2-methoxyethanol

Ketones
acetone
MEK (methyl ethyl ketone)
MIBK (methyl isobutyl ketone)



Others:
alcohols
carbon disulfide
d-limonene
DMF (dimethyl formamide)
ethylene glycol
THF (tetrahydrofuran)

How do solvents get into my body?

THERE ARE THREE WAYS: BREATHING, SKIN ABSORPTION, AND SWALLOWING.
Solvents that get into your body any of these three ways can harm your health if you are over-exposed.

BREATHING
You can breathe in solvents that have evaporated into the air. Many solvents evaporate very quickly, forming invisible **vapors.** When sprayed, they may also form visible **mists.** When you breathe vapors or mists, your lungs easily absorb the solvent into your bloodstream. This is a very common way for solvents to get into the body.

SKIN ABSORPTION
Liquid solvents can go into your body right through your skin. The solvents are then carried throughout your body in the bloodstream. Some solvents go through skin very fast, and others slowly.

SWALLOWING
Sometimes people accidentally drink a solvent. This can easily happen, for example, when someone has put solvent in a drink container. Starting a siphon by sucking solvent throught a tube also results in accidental swallowing.

Basic safe work methods for all solvents

"Everyone needs to know these basic facts!"

GET THE RIGHT STUFF
Start by using the safest solvent available for the job. You may be able to find a water-based or solvent-free substitute. Or, perhaps you can use a less toxic or less flammable solvent.

DON'T WASH YOUR HANDS WITH SOLVENT
Use a waterless cleaner, soaps, oils, detergents, anything but solvent. No solvent is safe for hand washing.

KEEP SOLVENTS OFF YOUR SKIN AND CLOTHES
Change your clothes if they get wet with solvent. (Solvent-soaked clothing can seriously overexpose you.) Wash solvent-contaminated clothes with soap or detergent. Use solvent-resistant gloves, aprons, or goggles if needed to prevent contact.

USE LESS
Use the smallest amount of solvent that will get the job done.

COVER CONTAINERS WHEN NOT IN USE
Keep solvent-soaked rags and waste solvent in closed containers. Clean up spills right away.

VENTILATION

Get fresh air by using fans that move vapors <u>out</u> of the work room. Don't just mix up the air inside the room.
Make sure fans and exhaust systems are turned on when solvents are used.
Ask your supervisor to repair ventilation systems that are not working effectively.

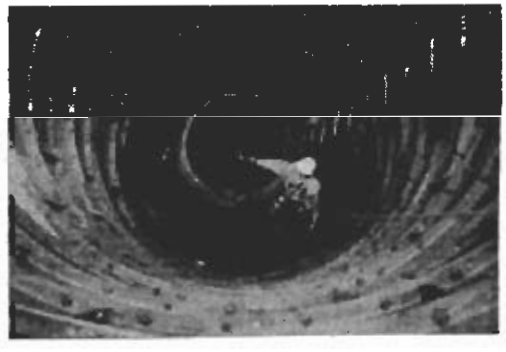
Exhaust fans should pull solvent vapors away from your face.

STORAGE

Keep solvents in labelled containers. Secure them against earthquake, fire, and vandalism. Never transfer solvents into drinking cups, cans or bottles.

DANGER: CONFINED SPACES

<u>Never</u> enter a tank, vat, or closed space that may be contaminated with solvent. Vapors can build up inside. Sudden death by poisoning, explosion, or lack of oxygen can result. Special training in "confined space" safety is needed before attempting this kind of work.



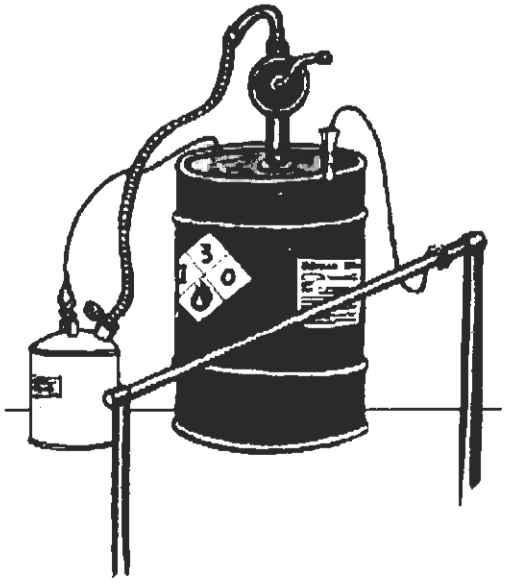
NO SMOKING OR HOT WORK

Don't smoke or do hot work near solvents or solvent vapors, even if the solvents are non-flammable. Non-flammable chlorinated solvents create very toxic fumes (phosgene) when heated.

WASTE SOLVENT

Dirty or used solvent is hazardous waste. Label it and store it carefully. Arrange for proper recycling or disposal. Don't pour it down the drain or on the ground; that's illegal, and it's dangerous to you and the environment.

Basic safe work methods for flammable and combustible solvents



FOLLOW THE BASIC SAFE WORK METHODS FOR ALL SOLVENTS, PLUS THESE:

CONTAINERS AND STORAGE
Use containers that are specially designed for flammable solvents. If you have more than a few pints of flammable solvents, use safety storage cabinets, or keep them in a separate room, away from combustible materials.

GROUND AND BOND METAL CONTAINERS when transferring flammable solvents. This prevents static electricity sparks. You do this by connecting containers to each other and to an electrical ground using clamps, wires, or direct metal-to-metal contact. The picture on this page shows one example. Get your supervisor to show you the right way for your situation.

KEEP THESE AWAY FROM FLAMMABLE SOLVENTS:

chromic acid	chlorine gas
compressed oxygen	compressed air
peroxides	nitric acid
	sulfuric acid

...and any chemicals labeled "oxidizer".
Oxidizers are chemicals that add oxygen, which can start fires or make fires burn faster. Don't use or store oxidizers near flammable solvents, or near other flammable materials.

NEVER USE GASOLINE EXCEPT AS A FUEL.
Never clean up with flammable solvents.

KEEP SMALL AMOUNTS IN THE WORK AREA
Keep only enough solvent for one day in the work area. Keep larger amounts in a separate, fireproof storage area.

Understanding fire hazards of solvents

FLAMMABLE SOLVENTS ARE DANGEROUS

Flammable solvents can catch fire at ordinary room temperature. All it takes is a spark or heat source touching the vapor. **Combustible** solvents can catch fire too, but only if they are warmer than 100 degrees F.

IT'S ACTUALLY THE VAPOR THAT BURNS

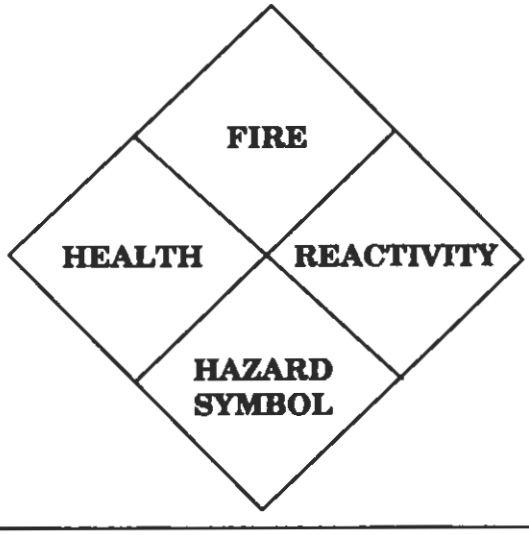
Sparks and heat must be strictly controlled wherever invisible vapors may be found. Usually heavy concentrations of vapors are found next to the surface of the liquid solvent. But in very bad ventilation conditions, **concentrated vapors can be found far from the liquid**. **Therefore, a fire can start where invisible vapors exist.**

WHAT IS A "FLASH POINT"?

The flash point is the lowest temperature at which a solvent gives off enough vapor to start burning when a heat source is present. Each solvent has a different flash point; low flash points are more dangerous. Flammable solvents have flash points of less than 100 degrees F.

THE NFPA DIAMOND is a diamond with four boxes that contain numbers and symbols. Fire hazards are rated in the top box. Health and reactivity (chemical reactions releasing energy) are rated in the side boxes. The greatest hazard is rated 4, on a scale of 0 to 4. The NFPA is the National Fire Protection Association.

CODE POSITIONS IN THE NFPA DIAMOND

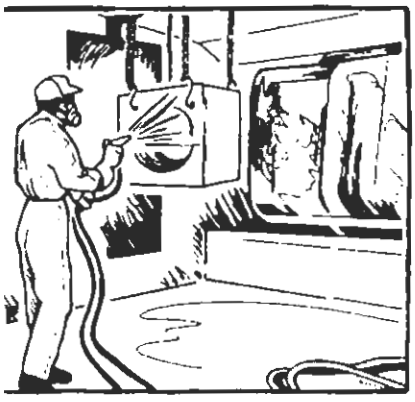


NFPA FIRE RATINGS FOR SOLVENTS:

- **0** not flammable: will not burn
- **1** combustible liquid: able to catch fire if heated over 100 degrees F.
- **2** flammable liquid: can catch fire at ordinary room temperatures (100 degrees F. or less)
- **3** highly flammable
- **4** explosive

Some standard safety practices

Here are some common jobs using solvents. For each job, some methods to reduce solvent hazards are listed.



SPRAY PAINTING

- adequate ventilation is very important since spraying generates a great deal of mist and vapor
- paint spray booths are required by Cal/OSHA for some operations
- if workers enter spray booth, respirators are usually required
- keep fire control sprinkler heads clean and free of overspray
- make sure electrical equipment is properly grounded
- keep all sources of sparks and heat away from flammable vapors, including lighting, moving parts, drying equipment, and ventilation fans
- non-solvent ingredients in paint are often highly toxic; watch for isocyanates, epoxy compounds, lead, chromates and cadmium; read the MSDS
- paint drying, paint mixing and storage rooms require ventilation
- avoid glycol ethers for cleaning spray equipment, or wear appropriate gloves to prevent skin absorption

DIP CLEANING and COLD DEGREASING

- hold parts in baskets or on hooks, not in your hands
- use lift devices to avoid leaning over tank, where most of the vapors are
- remove parts slowly so liquid drains from parts while they are still below top of tank
- install local exhaust ventilation at rim of tank
- cover tank when not in use
- let parts dry in a separate ventilated area, not in the work area

VAPOR DEGREASING

- parts should be totally dry when removed
- keep degreaser in good working condition
- keep strong air currents away from degreaser

GLUING / ADHESIVES IN MANUFACTURING

- local exhaust ventilation, using slots, hoods, or booths to capture vapors at the source

WIPING OR BRUSHING TO CLEAN

• store solvent-soaked or oil-soaked cloths in non-sparking, lidded containers

• when cleaning insides of barrels or other large containers, don't breathe accumulated vapors; use ventilation or respirators

• use gloves and aprons; if brushing, use goggles too

"Are any of these part of YOUR job?"

PAINT STRIPPING

• avoid methylene chloride strippers

• consider caustic strippers instead of solvents (skin and eye protection will still be needed)

FUELING / FLAMMABLE SOLVENT TRANSFER

• turn off the engine before fueling a vehicle or generator

• secure fuel tank cap and clean up any spills before starting the engine

• prohibit sources of heat or sparks near fueling area

• use containers and hoses suitable for the type of fuel

• maintain bonding or metal-to-metal contact between the solvent source and ground, and the destination container and ground

• transfer solvents outdoors or in a well-ventilated area

OFFSET PRINTING

• consider solvent-free inks

• avoid glycol ethers for blanket wash, or wear appropriate gloves to prevent skin absorption

DRYCLEANING

• solvent-recycling devices (sniffers)

• no-transfer machinery

• avoid carbon tetrachloride (carbon tet)

FIBERGLASS AND REINFORCED PLASTICS

• spray booths and spray corridors can be effective in controlling styrene and methyl styrene. General ventilation is not effective.

CARPET INSTALLATION

• use ethanol-based or water-based glues; other solvents are too toxic to use with the ventilation you will have at most work sites

How can I find out what solvents I use?

"What's in this stuff?"

READ THE LABEL
The label may show the chemical name or the brand name. Brand name products are usually mixtures of ingredients.

Each container must have a label. Employers must label all containers, large or small, of hazardous chemicals. That includes solvents.

GET TRAINING AT WORK
Employees have the right to know what hazardous chemicals they work with. Employers must train employees how to work safely with the chemicals, and teach them about hazards. Ask questions and be sure you understand how to protect yourself and your co-workers.

GET THE MATERIAL SAFETY DATA SHEET (MSDS)
It tells the ingredients and hazards. Your employer must have an MSDS at the work site for each product you use. The label name should match the MSDS name. You have the right to see the MSDS and to make a copy. You may want a copy to show to your doctor or to other experts.

LOOK IT UP
Information on MSDSs is usually very brief and incomplete. To find out more, write down the chemical names of the ingredients. Some solvents are listed in the Solvent Data Table on page 59. You can also call an expert once you know the chemical names.

Each solvent product must have a Material Safety Data Sheet.
The appearance of Material Safety Data Sheets can vary. This is one example. Only the first page is shown.

MATERIAL SAFETY DATA SHEET

CORPORATE RESEARCH & DEVELOPMENT

SCHENECTADY, N. Y. 12305

Phone: (518) 385-4085 DIAL COMM 8*235-4085

MATERIALS INFORMATION SERVICES

NO. 312

TRICHLOROETHYLENE

Revision D

Date July 1979

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: TRICHLOROETHYLENE

OTHER DESIGNATIONS: TCE, Trichloroethylene, Ethylene Trichloride, Ethenyl Trichloride, $CHCl=CCl_2$, GE Material D5B56, CAS# 000 079 016

MANUFACTURER & TRADE NAMES: BLACO-TRI (Baron-Blakeslee); ALK-TRI, NI-TRI and NEU-TRI (Dow); KAYNIDE (Kraft); PERM-A-CLOR and TRIAD (Detrex); TRICHLOR (PPG); TRICLENE D & MD (Diamond Shamrock)

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Trichloroethylene + Stabilizer*	ca 100	TLV 100 ppm with 200 ppm Ceiling level**
		Human, Oral LDLo 857 mg/kg
		Human, Inhal. TCLo 160 ppm/83 min (central nervous system)

*Stabilizers such as amines or epoxy compounds are usually added at low levels to increase resistance to oxidation and to polymerization. Vapor degreasing grades require higher stabilizer levels.

**ACGIH (1979 Intended Changes List) proposes an 8-hr TWA of 50 ppm with STEL 150 ppm. NIOSH (1978) reviewed TCE as a suspected carcinogen and suggested a TWA of 25 ppm as readily attainable. Unresolved controversy on TCE carcinogenicity at present.

SECTION III. PHYSICAL DATA

Boiling point, 1 atm, deg F (C)	188 (87)	Specific gravity 20 C	1.45-1.47*
Vapor pressure @ 20°C, mm Hg	58	Volatiles %	ca 100
Vapor density (Air = 1)	4.54	Evaporation rate (CCl_4=1)	~ 0.69
Water solubility @ 25°C, %	0.1	Freezing point, deg C	-73 to -86*
		Molecular weight	131.39

Appearance & Odor: Colorless, mobile liquid with a characteristic, sweet, ether-like odor whose recognition threshold is 21.4 ppm in air (unfatigued, 100% of test panel).

*Depends on stabilizer and level used.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits		LOWER	UPPER
None	770 F (410 C)	in air, Vol %	@ 57C	15	40
			@100C	2.5	90%

Extinguishing Media: Use that which is appropriate for surrounding fire. Trichloroethylene is normally considered noncombustible. However, when 15% vapor in air at 33 C is exposed to intense heat (electric arc) or to ordinary flame at vapor-air temperatures exceeding 50 C, it can be made to burn mildly. Combustibility increases in O_2-enriched air.

Self-contained breathing apparatus should be used for protection against TCE vapors and their toxic and corrosive decomposition products in a fire situation.

SECTION V. REACTIVITY DATA

TCE is considered to be a stable compound under normal conditions of storage and handling. However, when it is heated (as in a vapor degreaser) or exposed to sunlight, it requires stabilization against oxidation, degradation and polymerization. When it is exposed to high temperatures, hydrogen chloride and phosgene (highly toxic) can be produced as decomposition products. It is slowly decomposed by light when moist.

TCE can react with NaOH, KOH, or other strong alkali to form explosive mixtures of chloroacetylenes. Soda ash does not react.

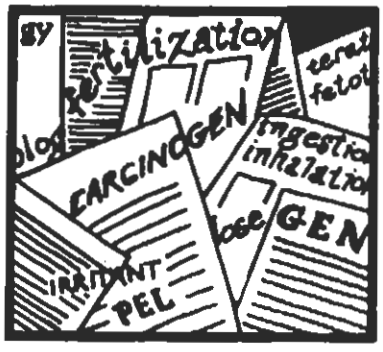
Polymerization of TCE is catalyzed by aluminum chloride. Magnesium or aluminum powder can react with TCE.

GENERAL ELECTRIC

Glossary of words used on Material Safety Data Sheets

Material Safety Data Sheets are often hard to read. You'll see many abbreviations and technical words. The list below explains some of the most common words used on MSDSs.

acute exposure: a brief exposure.



acute effects, acute toxicity: brief, temporary health effects which may be mild or severe.

asphyxiant: a gas or vapor that can cause unconsciousness or death due to lack of oxygen.

carcinogen, carcinogenic: can cause cancer. Usually this means the chemical has caused cancer in experimental animals.

CAS number: an identification number assigned to each chemical. The hyphens in the numbers are sometimes left out (555-55-5 is the same as 555555).

Ceiling Limit (C): Cal/OSHA's legal exposure concentration (Permissible Exposure Limit) that must not be exceeded, even for a moment. Many solvents have ceiling limits.

chronic exposure: long exposure to a chemical, usually months or years.

chronic effects, chronic toxicity: long-lasting health effects; or, effects caused by long-term exposure.

CNS depression: a condition of the brain (central nervous system) causing dizziness, drunkenness, fatigue, clumsiness, unconsciousness or death.

combustible liquid: a liquid that can catch fire at 100 degrees F or higher. They are less dangerous than flammable liquids.

explosive limits: When vapors of a flammable solvent are

mixed with air in the right proportions, they will explode if ignited. Very low or very high concentrations cannot explode. Explosive limits define these proportions (percentage of vapor in air). The LEL and UEL are the Lower and Upper Explosive Limits. Solvent PELs are usually given in ppm units (parts per million), while explosive limits are in percent (parts per hundred).

exposure: contact of a person with a chemical, by breathing, touching, or swallowing.

flammable liquid: a liquid that can catch fire at low temperatures (100 degrees F or less). This is very dangerous because a fire can start at ordinary room temperature. All it takes is a spark or heat source touching the vapor.

flash point: the lowest temperature at which a solvent gives off enough vapor to start burning when a heat source (spark, hot work) is present. Each solvent has a different flash point. Chemicals with low flash points are more dangerous.

hazardous substance: may refer to any substance that is a health hazard or fire hazard; or, may refer to certain lists of "hazardous substances" published by Cal/OSHA, Federal OSHA, EPA or others .

incompatible chemicals, incompatibility: two chemicals that may burn or explode if mixed together.

inflammable: will burn easily (same meaning as flammable).

irritant: can hurt the eye, skin, or lungs directly on contact.

LEL: see "explosive limits."

mg/m^3: milligrams per cubic meter; one unit of measurement for chemicals in air (compare to "ppm").

mmHg: millimeters of mercury; a measure of vapor pressure (see below for explanation of "vapor pressure"). Sol-

vents that evaporate slowly have a low vapor pressure, with mmHg of approximately 0 to 5. Solvents that evaporate more quickly have higher vapor pressures, ranging from 10 up to several hundred mmHg.

mutagenic: can damage genes, possibly causing cancer.

narcosis, narcotic: poisoning of the brain (central nervous system) causing dizziness, drunkenness, fatigue, clumsiness, unconsciousness or death.

NFPA code: a hazard code picture for each material, in a diamond shape with four boxes (clockwise from top) representing: fire/explosion, chemical reactivity, special hazards, and health (toxicity). Each box contains a word or a number. Numbers range from 0 (not a hazard) to 4 (extremely hazardous). See illustration on page 8.

oncogenic: can cause cancer (same as carcinogenic).

oxidizer, oxidizing agent: a chemical that starts fires, or makes them burn faster and hotter, by giving oxygen to the fuel. Store oxidizers away from flammable solvents. Sometimes abbreviated *OX.*

PEL (Permissible Exposure Limit): a legal limit to the amount of a specific chemical allowed in workroom air, usually averaged over a full work day. If the PEL says "S" or "skin", it means your skin can absorb the chemical and the employer must protect you against skin contact. Only about 600 of the most common chemicals have PELs; thousands of other hazardous chemicals are not regulated by Cal/OSHA and have no PELs.

personal protective equipment: refers to gloves, respirators, and other devices worn by individuals.

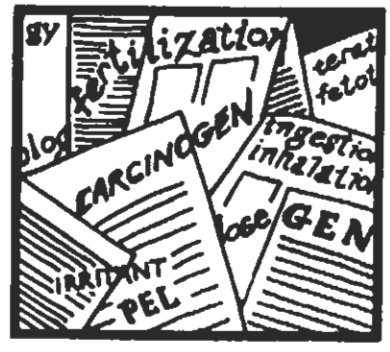
ppm: parts per million; one unit of measurement for chemicals in air. (The other is mg/m^3.) One part solvent in a million parts of air equals 1 ppm.

reactivity: ability of a substance to combine chemically with other substances. Reactivity can cause fires, explosions, container rupture, or hazardous byproducts.

reproductive hazard: can harm male or female ability to produce a healthy child. This can include effects on sexual function, menstrual function, fertility, miscarriage, birth defects, breast milk contamination, and damage appearing later as the child grows (such as mental or physical developmental delays).

respiratory protection: same as respirators.

"skin": see "PEL"



STEL (Short Term Exposure Limit): a kind of PEL *averaged over* short periods of exposure, such as 10 or 15 minutes, instead of a full workday.

teratogen, teratogenicity: can cause birth defects. Usually means the chemical has caused birth defects in experimental animals.

torr: a measure of vapor pressure (see below). 1 torr equals 1 mmHg.

toxic: poisonous; a substance that is "very toxic" or "highly toxic" can harm your health, even if you only take in very small amounts.

TWA, Time-Weighted Average: a way of measuring exposure to get the average. Most PELs are 8-hour Time-Weighted Averages.

UEL: see "explosive limits."

vapor pressure: a measure of how quickly a substance can evaporate (form a vapor). Usually stated in units of mmHg or torr (see above).

VOCs, volatile organic compounds: carbon-containing liquids that evaporate easily. Most VOCs are solvents.

volatility: tendency to evaporate (change from liquid to vapor). The more volatile a solvent is, the faster it evaporates.

What health problems can solvents cause?

YOUR BRAIN:
"SOLVENT INTOXICATION"

Overexposure to most solvents can affect your brain the same way that drinking too much alcohol can. You may feel "high," dizzy, or drunk. You may also have:

- Headaches
- Nausea (feeling sick to your stomach)
- Tiredness and irritability
- Difficulty concentrating
- Clumsiness

These symptoms are a warning that you have absorbed too much solvent! Just as with alcoholic drinks, a small amount may not affect you, but a larger dose will hurt you.

Usually, these effects go away within a few hours after you stop absorbing the solvent. You may feel sick at work and better at home.

People who are "high" or sleepy from solvents may injure themselves or others, by misuse of vehicles, equipment, or chemicals.

Massive overexposure to solvents can cause sudden death.

YOUR SKIN

Solvents dissolve the natural protective oils in your skin. This can dry out your skin, making it red, flaky and cracked. This is called **irritant dermatitis.** Dermatitis can appear on any part of your body that is repeatedly in contact with solvents, but the most common location is on the hands.

Severe dermatitis

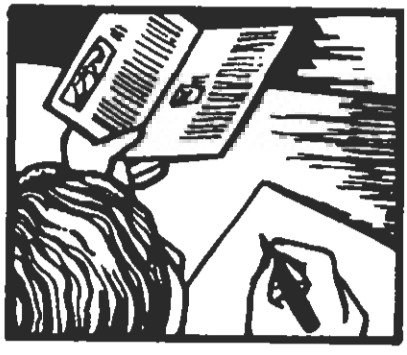
Dermatitis can be painful, and can make it difficult for you to work. When exposure to the solvent stops, the skin usually heals within a week or two.

Another kind of skin problem caused by some solvent products is **allergic contact dermatitis.** Symptoms are redness, itching, hives, and sometimes blisters. A few solvents, including d-limonene and turpentine, cause this problem. If you become allergic, you may react to very small amounts that would not affect most people.

LUNGS, NOSE, AND THROAT

Solvent vapors can temporarily irritate your lungs, nose, and throat. Symptoms include irritation or soreness of the nose and throat, hoarseness, coughing, lung congestion, chest tightness, and shortness of breath. This can worsen the symptoms of cigarette smoking, and may cause or worsen asthma (periods of wheezing and difficulty breathing).

Dermatitis from solvent drip onto sleeve



HEAVY, LONG-TERM USE

Workers who are overexposed to solvents for months or years can suffer permanent health damage. Effects include memory loss, hearing loss, mental illness, depression, fatigue, confusion, kidney damage, and liver damage. These symptoms may increase gradually during the years of working with solvents. After you stop working with solvents, symptoms usually don't get better or worse.

If you have had long periods of overexposure, use the questionnaire on page 35 to help detect brain effects due to solvent overexposure.

One recent research study of people with Alzheimer's disease found an unexpectedly high number of people who had worked with solvents for many years. We don't yet know if solvents actually are a cause of Alzheimer's.

IF YOU DRINK ALCOHOL

Alcoholic beverages contain ethyl alcohol, which is also a solvent. If you drink liquor, beer or wine after a day of working with solvents, their effects add together and could make you sick. Ethyl alcohol, like other solvents, can affect your brain and liver.

SOLVENT VAPOR IN EYES

Eye contact with solvent vapors can cause eye irritation. Your vision may briefly become distorted. Some solvents may also temporarily affect your color vision.

IF SWALLOWED

Solvents can cause death if swallowed. Also, if you vomit, some solvent may go into the lungs. This can be fatal. For this reason, do not induce vomiting if someone has swallowed a solvent. Call a poison control center immediately for advice.

ODORS ALONE CAN CAUSE TEMPORARY ILLNESS

Strong smells alone can cause symptoms such as headache, nausea, and vomiting, without otherwise hurting you. Even odors that are pleasant at low levels may cause symptoms at higher levels. It may be difficult to determine whether illness is caused by odor or by the toxic effects of a solvent.

SOLVENT SNIFFING AND SOLVENT ADDICTION

Sudden death or serious illness can result from sniffing solvents. Also, after repeated overexposure, your body can develop a craving (addiction) for solvent. Inhaling solvents on purpose is called sniffing or huffing.

DON'T IGNORE SYMPTOMS OF ILLNESS

If one person has health problems due to solvents, it's a warning sign for others in the area.

SPECIAL HEALTH HAZARDS FROM CERTAIN SOLVENTS

Overexposure to most solvents can cause brain intoxication, dermatitis, and the other effects described above. However, certain solvents also have one or more of the following special health hazards. Be extra careful to avoid overexposure if you must use these solvents.

•**Cancer.** Only one solvent is clearly known to cause cancer in humans: benzene (causes leukemia). We suspect that the following solvents also cause human cancer, based on animal tests: methylene chloride, carbon tetrachloride, chloroform, dimethylformamide, dioxane, perchloroethylene and trichloroethylene.

•**Birth defects and miscarriage.** Pregnant women risk harm to the unborn baby if they use certain glycol ethers, or if they absorb large amounts of other solvents (see page 27).

•**Infertility.** Men risk low fertility (decreased sperm count) if they use certain glycol ethers (see page 30).

Blood tests can detect liver and kidney damage.

•**Nerve damage.** Certain solvents can cause **peripheral neuropathy.** The symptoms include numbness, weakness, pain or "pins and needles," typically in the hands and/or feet. Solvents known to injure nerves are n-hexane and methyl n-butyl ketone (2-butanone). Solvents that are suspected to damage nerves are toluene, 1,1,1-TCA, 1,1,2-TCA, and Fluorocarbon 11. In addition, TCE (trichloroethylene) can damage facial nerves.

•**Liver and kidney damage.** Some solvents are much more potent than others in causing chemical hepatitis, kidney failure, or glomerulonephritis (a kidney disease). They include carbon tetrachloride, chloroform, dimethylformamide, d-limonene, methyl chloride, perchloroethylene, styrene, toluene, 1,1,2-trichloroethane, trichloroethylene, xylene. Blood tests can detect liver and kidney damage.

•**Heart attacks and angina.** Methylene chloride and carbon disulfide can worsen pre-existing heart disease.

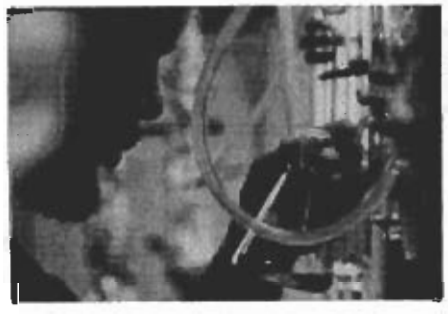
•**Heart arrhythmia.** Heart arrhythmia is a dangerous irregular heart rhythm. Symptoms include heart palpitation, "skipped heart beats," or dizziness. It has been caused by overexposure to certain fluorocarbons (some are trademarked Freon). Overexposure to trichloroethane, or to other chlorinated solvents, has sometimes caused arrhythmia also.

Recognizing unsafe solvent situations

How can you tell if you are being overexposed? Occasional use of small amounts of solvent is likely to be safe. But in many situations, it is hard to judge health risks without testing the air. Here are some things to look for.

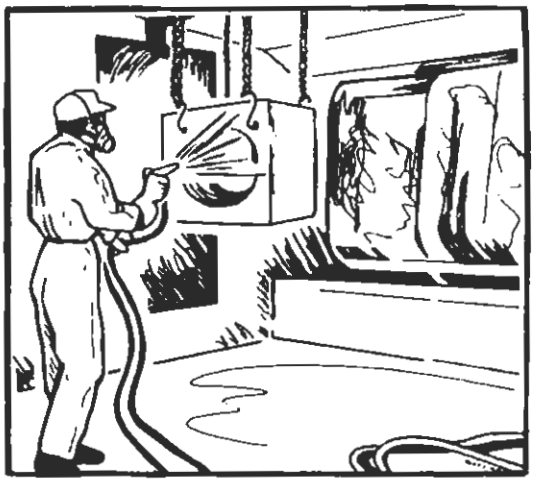
WILL THE ODOR WARN ME?
NO!! Don't depend on the odor of a solvent to tell you if it's unsafe. Many vapors are unsafe even in amounts that cannot be smelled. Other solvents have a strong odor even at harmless concentrations. The Solvent Data Table shows the odor warning abilities of some solvents (see page 59).

The sense of smell is more sensitive in some individuals than others. Also, a person stops noticing smells after being around them for a while ("olfactory fatigue").

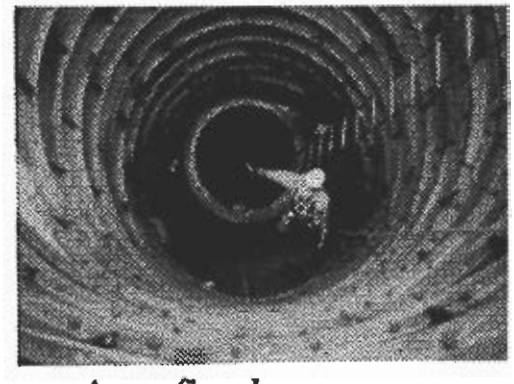


"Hmmm...I don't notice the solvent smell anymore."

AIR TESTS PROVIDE YOU WITH IMPORTANT INFORMATION
Your employer is responsible for getting the air tested if it may not be safe. You have the right to see and copy air test results that affect you. If tests show illegal amounts of vapors, Cal/OSHA rules require your employer to correct the problem. However, even legal levels can sometimes cause health problems.



Paint spraying



A confined space

COULD I BE OVEREXPOSED TO VAPOR?

Each of these situations is likely to produce unsafe concentrations of vapor:

- working inside tanks, holds, vessels, sumps, or pits (**confined spaces -- DANGER!**)
- working in a small room or a poorly ventilated area.
- spraying solvents, or spraying mixtures that contain solvents
- spreading solvent-containing coatings over a large area, such as painting, printing, solvent stripping, or gluing
- using highly volatile solvents (liquids that evaporate quickly). The Solvent Data Table shows the volatilities of some solvents (see page 55).
- heating solvents
- using extremely toxic solvents (check the Solvent Data Table).

CONFINED SPACES

A **confined space** is any place where fresh air does not come in. Dangerous conditions can result if there is any chemical contamination. Confined spaces usually are:

tanks	pits	holds
silos	vats	vessels
boilers	ducts	tubs
sewers	vaults	bins
compartments		

Just reading this booklet does <u>not</u> enable you to work safely in confined spaces. Your employer must train you and provide special equipment and staffing.

If my health or safety may be in danger, what should I do?

TELL YOUR SUPERVISOR

Always report the situation to your supervisor. You may also have a health and safety committee, a company safety coordinator, or a union representative. Ask management to fix the problem. Describe the chemicals, work practices, ventilation, symptoms, and other facts. Work toward a solution.

SEE A DOCTOR

If you suspect that your health is affected by solvents, get medical care. Bring a copy of the MSDS. Your condition may be treatable. Also, a doctor may be able to recommend protective measures you need to take at work.

CALL CAL/OSHA

Cal/OSHA (the California Division of Occupational Safety and Health) is a source of free information on health and safety. You have the right to file a complaint; if you do, Cal/OSHA may send an officer to inspect the workplace and enforce safety regulations. Workers filing such complaints are legally protected, but often face problems from their employers.

FIND OUT ABOUT WORKERS' COMPENSATION

Workers' Compensation insurance will pay certain medical bills and disability payments if they agree that your work caused all or part of your illness. Workers' Compensation should also cover the costs of finding out whether your work caused your illness.

REFUSE TO DO DANGEROUS WORK

You have the right to refuse work that presents a real and apparent hazard to your safety or health, or work that violates any Cal/OSHA standards. You cannot legally be laid off or fired for refusing such work (California Labor Code section 6311). However, employers often dispute that there is a "real and apparent" hazard. Consult your union or a legal aid organization.

Pregnancy and breastfeeding

START NOW
Find out about workplace hazards and begin to protect yourself **before** you become pregnant. The fetus is most likely to be harmed by chemicals in the first three months, before you may realize you are pregnant.

DO YOU HAVE SYMPTOMS OF OVEREXPOSURE?
In general, most solvents are not likely to be harmful to the developing baby if the mother herself is not overexposed. If you do not have symptoms, your exposure is probably not enough to affect the fetus.

LOOK OUT FOR GLYCOL ETHERS
Some of the "glycol ether" solvents are important exceptions: they cause birth defects in test animals and probably are dangerous to the unborn child in amounts that will not bother the mother. They probably also increase the risk of miscarriage, and may affect fertility. There are many different glycol ether solvents, each with several names (see page 27).

YOU HAVE LEGAL RIGHTS
If your doctor says you shouldn't do your regular work during your pregnancy, you may have the right to temporary transfer to a safer job, disability benefits, unemployment benefits, or unpaid leave. Workers who are disabled by pregnancy generally have all the rights other temporarily disabled workers have; however, businesses with few employees are exempt from some requirements. For information about disability and unemployment benefits, call the California Employment Development Department. For information about unpaid leave and complaints of discrimination, call the California Department of Fair Employment and Housing.

MINIMIZE SOLVENT EXPOSURE

The best way to protect yourself and your baby is to keep your exposure to hazardous chemicals low. You may be able to lower the amount of solvents entering your body by following the safe work practices in this booklet. Or, you may be able to transfer to a different job that doesn't involve hazardous chemicals. Some women decide to stop working during pregnancy, but this is not the best choice for everyone, especially if it means losing health insurance.

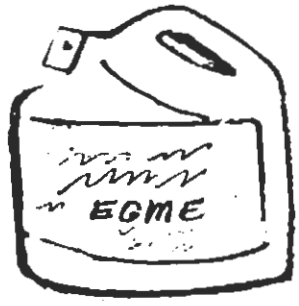
"Pregnancy disability must be treated like any other temporary disability"

BREASTFEEDING

Solvents can get into breast milk. If a mother works with solvents and breastfeeds her child, the baby can be affected just like the mother, and may sometimes be more sensitive.

NUTRITION AND MEDICAL CARE

Working with chemicals is only one of many things which can affect your pregnancy. The foods you eat, avoiding smoking and alcohol, and good prenatal medical care are very important. Eat well and start seeing a doctor early in your pregnancy.



GLYCOL ETHERS THAT ARE REPRODUCTIVE HAZARDS TO WOMEN AND MEN

ABBREVIATION C.A.S. NUMBER[1]	COMMON NAME CHEMICAL NAME
DEGDEE 112-36-7	diethylene glycol diethyl ether bis(2-ethoxyethyl)ether
DEGME 111-77-3	diethylene glycol monomethyl ether* 2-(2-methoxyethoxy)ethanol
DEGDME 111-96-6	diethylene glycol dimethyl ether bis(2-methoxyethyl)ether
EGME 109-86-4	ethylene glycol monomethyl ether* 2-methoxyethanol
EGMEA 110-49-6	ethylene glycol monomethyl ether acetate* 2-methoxyethyl acetate
EGEE 110-80-5	ethylene glycol monoethyl ether* 2-ethoxyethanol
EGEEA 111-15-9	ethylene glycol monoethyl ether acetate* 2-ethoxyethyl acetate
EGDME 110-71-4	ethylene glycol dimethyl ether 1,2-dimethoxyethane
EGDEE 629-14-1	ethylene glycol diethyl ether 1,2-diethoxyethane
TEGDME 112-49-2	triethylene glycol dimethyl ether

Glycol ethers are often sold under these trademarks:
Cellosolve, Carbitol, Dowanol, Ektasolve.

Many other brand names contain some glycol ethers as ingredients.

[1] The C.A.S. number is the identification number assigned to each chemical by the Chemical Abstract Service.
* Note: in chemical names, the prefix "mono" can be left out. For example, "monomethyl" is the same word as "methyl".

What if I may father a child soon?

There are a few solvents and other chemicals that should be avoided by prospective fathers.

GLYCOL ETHERS

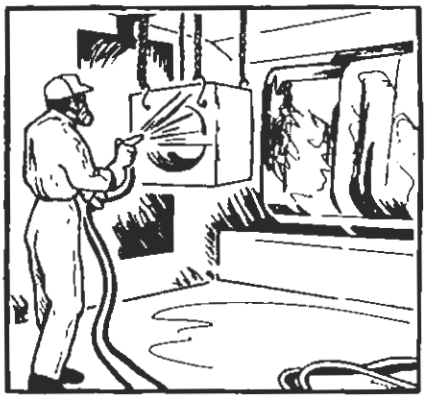
The "glycol ether" solvents listed on the previous page can lower sperm count and sometimes make a man unable to father a child. There are many different glycol ether solvents, each with several chemical names. Most glycol ethers that are not listed on the previous page do not have these effects.

OTHER TOXICS

Some chemicals besides solvents, such as certain pesticides, lead dust, lead fume, and lead compounds, can damage male reproductive health and the health of your child. Men should avoid working with these toxics for at least 3 months before fathering a child.

Very little is known about whether a father's exposure to most chemicals can cause birth defects or other damage to his child.

What if I must use a respirator?



IS YOUR RESPIRATOR REALLY WORKING?
Many people think their respirator works, when it doesn't. You could have the wrong kind of respirator wrong kind of filter cartridges, leakage and fit problems, or worn-out filter cartridges. Also, filter cartri respirators just don't work for certain chemicals.

DOES YOUR EMPLOYER HAVE A PROPER RESPIRATOR PROGRAM?
The law requires a complete written plan that discusses respirator selection, fitting, training, etc. See page 49 for more on Cal/OSHA requirements.

TRY TO USE VENTILATION INSTEAD OF RESPIRATORS
By law, employers must use engineering methods (such as fans, local exhaust ventilation, or sealed machinery) to make the air safe, if possible. Make fu use of the ventilation you have.

Ordinary dust masks are useless against solvent vaports

GET THE RIGHT KIND
Dust masks, surgical masks, and handkerchiefs do NOT protect at all against solvent vapors. Don't automatically choose an organic vapor ("OV") filter cartridge respirator. A respirator must be right for t kinds of solvents you use, the amount of vapor in the air, and your work situation. See page 48 for a description of the different respirator types.

GET THE RIGHT FIT
Any respirator will leak between the mask and face, unless it is fitted right. You must be individually "fi tested" by a trained person when you receive your respirator. There are various mask sizes and shapes Masks can be "full face" (over the eyes, nose and mouth) or "half face" (nose and mouth only). Facial hair under the sealing edge allows vapor to leak into the mask.

EACH TIME YOU USE YOUR RESPIRATOR:

- **Look it over.** Before you put it on, check it for cracks, damage, or loose parts.
- **Check the fit.** After you put it on, check the fit yourself. For respirators with masks that seal to the face, do "positive pressure" and "negative pressure" fit tests. These tests are done with the respirator on; block the valves, then exhale and inhale, checking for leaks.
- **Clean it up.** After use, clean the respirator, if necessary, using soap and water.
- **Protect it.** Store it in a sealed plastic bag to protect it from dirt and vapors. Protect it from crushing which could deform the shape of the face mask.

DON'T USE FILTER CARTRIDGE RESPIRATORS FOR ALL SOLVENTS

Solvents with poor odor warning ability, such as Freon, carbon tetrachloride and methylene chloride, are not safe to use with filter respirators. You need an odor to warn you at the end of cartridge life or if the respirator leaks. Check the Solvent Data Table on page 55 for the solvents you use.

REPLACE FILTERS OFTEN

Filters may last for a few minutes or a few days of use, depending on the situation. Old filters let vapors leak through. Replace the filters whenever you smell leakage into the mask; you should never be able to smell the chemicals at all when you're wearing the respirator.

IF YOU HAVE A HEART OR LUNG DISEASE, check with a doctor to make sure you can safely use your respirator.

SOLVENT SAFETY CHECKLIST

SOLVENT SELECTION

The chemicals you use are the safest ones that can do the job.

TRAINING

The employer trains workers and requires workers to use safe work practices.

Workers learn how to work safely before starting a new assignment or facing a new hazard.

Workers know the chemical ingredients of the products they use.

Workers know the fire hazards and health hazards of the chemicals they use.

Workers know safe work methods and emergency procedures (fire, spill, first aid) for the specific chemicals they use.

Material Safety Data Sheets are kept on site, available to chemical users.

Workers report the following to their supervisor:

- Unsafe conditions
- Work-related injuries and illnesses

CONTAINERS

Each container has a label showing the chemical name and hazard warnings.

If chemicals must be transferred from the original containers, the new containers are labeled with the chemical name and hazard warnings.

Only approved containers are used for flammable solvents.

Containers are closed or covered when not in use.

Incompatible chemicals are stored separately from each other.

Only small amounts of flammable solvents are kept in the work area (enough for one day only).

SOLVENT SAFETY CHECKLIST

GLOVES, GOGGLES

If gloves, goggles, or other protective clothing are needed to keep solvents away from skin, eyes, and clothing:
They are made of material that really keeps out the chemicals.

They are replaced before they get worn out, cracked, soaked through or spongy.

AIR CONTAMINATION

If there are work areas that may have unsafe air to breathe:
The employer has tested the air in these areas.

Workers have been given the test results.

If ventilation is used (fans, ducts, hoods), it has been tested and maintained in the last year.

If respirators are used, there is a complete OSHA respirator program. (Ventilation must be used instead of respirators, if possible.)

If workers must enter confined spaces, there are special procedures and training.

DOCUMENTATION

There is a written "Injury and Illness Prevention Program."

The person responsible for general safety and health is:

FOLLOWUP ITEMS:

ACTION	DATE

Date: **Your Name:**

QUESTIONNAIRE FOR LONG-TERM SOLVENT-EXPOSED WORKERS

This questionnaire is used to help determine whether long-term overexposure to solvents has affected the central nervous system (brain). Answer Yes or No to each question. After you finish, read the instructions to interpret the results.

1. Do you have a bad memory? Yes ❑ No ❑
2. Have your relatives told you that you have a bad memory? Yes ❑ No ❑
3. Do you often have to make notes about what you must remember? Yes ❑ No ❑
4. Do you often have to go back and check things you have done, such as turned off the stove, locked the door, etc.? Yes ❑ No ❑
5. Do you generally find it hard to get the meaning from reading newspapers and books? Yes ❑ No ❑
6. Do you have problems with concentrating? Yes ❑ No ❑
7. Do you often feel irritated without any particular reason? Yes ❑ No ❑
8. Do you often feel depressed without any particular reason? Yes ❑ No ❑
9. Are you abnormally tired? Yes ❑ No ❑
10. Are you less interested in sex than what you think is normal? Yes ❑ No ❑
11. Do you have heart palpitations even when you don't exert yourself? Yes ❑ No ❑
12. Do you sometimes have a feeling of pressure in your chest?

13. Do you perspire without any particular reason? Yes ❑ No ❑

14. Do you have a headache at least once a week? Yes ❑ No ❑

15. Do you often have a painful tingling in some part of your body? Yes ❑ No ❑

EVALUATING THE QUESTIONNAIRE RESULT

This questionnaire was developed based on clinical experience with workers who were exposed to solvent mixtures for many years. In general, if a solvent worker gives six or more Yes replies, it is advisable to get a medical evaluation. The questionnaire alone cannot prove that there was health damage due to solvents.

See a doctor if you are concerned about possible health effects of working with solvents. See page 53 for information on locating an appropriate doctor, such as a physician certified in occupational medicine. Note that some solvents affect other organs besides the brain. This questionnaire was designed to detect brain effects only.

The questionnaire in this booklet was adapted from the Swedish Q16 questionnaire, from the Textbook of Clinical Occupational and Environmental Medicine, Rosenstock and Cullen, W.B Saunders Company.

PART TWO: MANAGING SOLVENT SAFETY AND HEALTH

ABOUT PART TWO

Part Two of this booklet outlines how to select a solvent product, how to decide which ventilation system and protective equipment to use, and how to comply with Cal/OSHA regulations for employee training, respirators, and air contaminants.

Read Part One first to review the fundamentals of solvent hazards. Part Two assumes some familiarity with the terms and topics covered in Part One.

Management approach

BE PRO-ACTIVE

A pro-active approach prevents problems that could result from using solvents and other toxic chemicals. Management of solvent safety doesn't have to be complicated. If a company begins by evaluating the hazards of chemicals, it can select the least troublesome products. Then it can provide practical employee training, appropriate protective equipment, and periodic safety inspections.

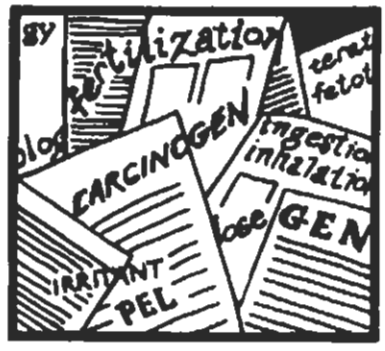
MANAGEMENT RESPONSIBILITIES

Management is legally responsible for all workplace safety. Employers must create a safe work environment and enforce safe work rules for employees. Management is responsible for knowing laws and regulations.

GAINING COOPERATION

In practice, effective safety is the result of actions taken by managers, supervisors, and solvent users. Employee training is an essential part of safety management. One way to promote safety planning and cooperation is forming a safety committee with both labor and management representatives. Another useful practice is to make safety performance part of the performance evaluation for everyone in the company.

Air contaminants



EMPLOYERS MAY NEED TO TEST AIR CONTAMINANT LEVELS

Employers are responsible for finding out whether the amounts of air contaminants breathed by their employees are below the Permissible Exposure Limits set by Cal/OSHA.

DON'T RELY ON ODOR

Remember, odor is not a good indicator of safety for solvents. Many solvents have no odor even at harmful levels. Others have strong odors even at harmless levels. Either way, the odor does not warn of overexposure. Measuring the amount of a substance in the air is the only reliable way to determine the airborne exposure level.

WHICH AREAS REQUIRE TESTING?

Employers should review the section "Recognizing unsafe solvent sitations" (page 23) to become aware of situations they should evaluate. Situations where small amounts of solvents are used usually don't call for air tests. However, air tests are often necessary for proper selection of respiratory protection. Call an expert for advice if you are not sure.

Labels

WHY LABEL?

Labeling of solvent containers is an effective way to reinforce your training program, reduce errors, and prevent accidents. Minimum OSHA requirements for labels on each container of hazardous chemicals are:

- the name of the chemical or product
- important hazards, such as flammability or special health hazards
- (for the original container only) the name and address of the chemical manufacturer.

ADDING TO THE LABEL

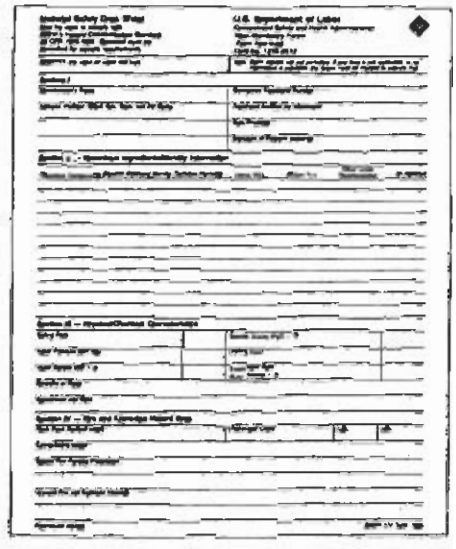
To increase the benefits of labels, you may add the following information:

- any protective clothing or equipment that is required
- brief instructions for safe use
- the chemical contents of the material
- symbols or pictures representing protective clothing
- bilingual information.

GETTING LABELS

Look for proper labeling when you buy chemical supplies. Several safety supply companies sell informative safety labels for common chemicals, or you can write or print out your own. Extra labels are necessary if you dispense chemicals into other containers.

Material Safety Data Sheets



THE EMPLOYER'S RESPONSIBILITY

Employers are required to obtain the MSDSs from the manufacturer or the distributor and to make them readily available to employees. Post the MSDSs, or collect them in a binder in the workplace, and make sure employees know about them.

WHY DO YOU NEED MSDSs?

Industrial products are made up of many different chemicals, including solvents. Both managers and users need to know the ingredients and hazards of products. Material Safety Data Sheets (MSDSs) were created to meet this need.

THE MSDS REGULATION

The California Hazard Communication Standard (General Industry Safety Order 5194) gives employers and employees the right to know the health and safety hazards of products used on the job. This standard requires chemical manufacturers and importers to provide hazard information to employers by means of Material Safety Data Sheets (MSDSs). A similar federal law exists, so products from all states, and imported products, have MSDSs.

WHAT'S ON THE MSDS?

An MSDS lists the hazardous ingredients of a product, any health and safety hazards, and ways to use the product safely. The MSDS should also tell you about any unusual hazards, first aid, and methods for cleaning up leaks and spills. This information is valuable for both management and worker training.

TRADE SECRET INGREDIENTS

Some MSDSs withhold the identity of chemical ingredients as trade secrets. If you are concerned about trade secret ingredients you can call the emergency phone number listed on the MSDS and ask for a complete list of ingredients. A physician treating a patient has the right to receive this information.

Replacing hazardous solvents with safer substitutes

IS SUBSTITUTION FOR YOU?

If the solvents you use are hazardous, expensive, or have environmental restrictions, consider switching to a substitute product. New types of inks, coatings, cleaners and strippers are constantly being formulated. They use water, non-solvent chemical ingredients, or alternative solvents in the place of traditional solvents. Trade magazines can keep you up to date on new products available for your industry.

EVALUATING POSSIBLE SUBSTITUTES

Sometimes substitutes solve one problem and cause another. You must evaluate how the product will perform in your workplace. Request a Material Safety Data Sheet before you buy, along with the technical specifications. Besides checking the health and fire sections, look at the evaporation rate, method of application, or any other factor that would affect the amount getting into the air or on skin. Check for all toxic ingredients in the product, not just solvents.

COSTS TO CONSIDER WHEN SELECTING A SOLVENT (OR SOLVENT SUBSTITUTE)

Cost is not just the price per gallon of a product. Consider what you will pay for the whole process involved in using that product:

- Costs of worker protection, such as ventilation, respirators, gloves, special containers.
- Costs of accidents or illnesses due to toxic effects. Solvent dizziness can make accidents more likely. These costs are both human and economic.
- Costs of environmental controls and disposal for hazardous wastes.
- Quality of your finished job.
- Efficiency costs; which product is faster-acting, faster-drying, quicker to apply, easier to clean up.
- Costs of related tools or equipment.

Using ventilation to create healthier working conditions

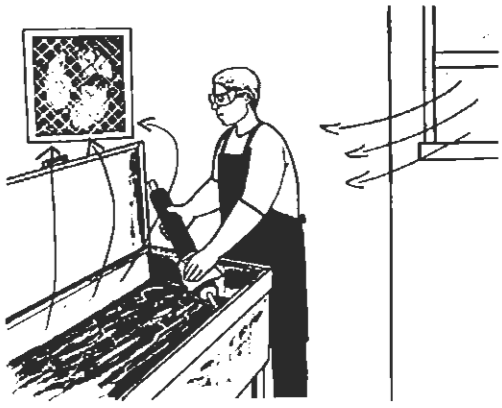
VENTILATION SOLVES PROBLEMS

Ventilation is an excellent way to create safe conditions for work with volatile solvents. Unlike respirators, ventilation doesn't interfere with the work or with worker comfort. If properly designed, it is very effective in protecting health.

VENTILATION POINTERS

Always use fans that move vapors (solvent "fumes") out of the room. Also provide a way for clean, fresh air to enter the room.

- Don't use fans that just mix up the air inside the room.
- Fans are most effective when they remove vapors at the source, by pulling the air away from the work.
- Position the fresh air intake away from polluted areas (such as chemical exhaust vents, combustion flues, loading docks, and garages). In the workroom, locate the fresh air intake far away from the exhaust fan. Outdoors, locate the exhaust stack downwind from the intake, and as far away as possible.



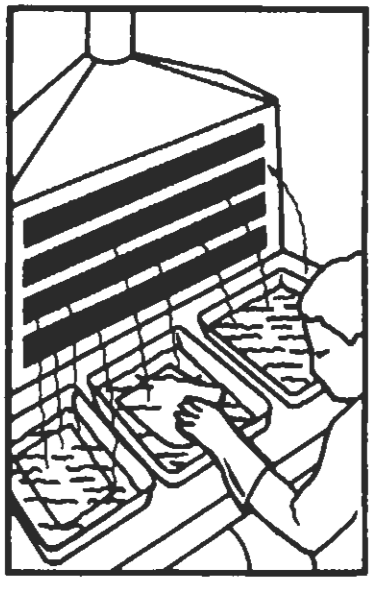
General ventilation with wall exhaust fan

GENERAL VENTILATION

For light use of less-toxic solvents, use general ventilation. If enough fresh air flows through the room, it will dilute vapors to safe levels. Recirculation of exhaust air, often used in office buildings, should be avoided in solvent work areas.

LOCAL EXHAUST VENTILATION (LEV)

Some situations require local exhaust ventilation, such as paint spray booths and laboratory hoods. LEV is very effective for the control of high-hazard solvent operatons. It consists of specially designed enclosures that capture and remove vapors at their source.



Local exhaust ventilation with custom-designed hood

DESIGNING THE SYSTEM

To design a ventilation system, consult an industrial hygienist or engineer experienced with industrial ventilation. Poorly designed systems are ineffective or inefficient. Design factors should accomodate:

- Permissible Exposure Limits and other regulatory standards
- heating and cooling needs
- makeup air supply
- for LEV, capture velocities and hood design
- duct specifications and provision for clean-out
- fan specifications and planning for future capacity needs

MAINTENANCE IS ESSENTIAL

Inspect and maintain ventilation systems annually. Like any equipment, it will need cleaning, lubrication and adjustment to continue working up to specification. Inspection of local exhaust systems should include measuring air velocities at specific locations.

MAKE IT FAIL-SAFE

Include a way for workers to recognize ventilation system failure. Odor is an unreliable warning signal. A visual indicator is good, such as a pressure gauge or air-blown ribbons. Train workers to check the system at the beginnning of each shift.

VAPOR RECOVERY

Solvent vapors can be removed from the exhaust air by additional machinery. Vapor recovery produces recycled liquid solvent and also reduces vapor emissions from your facility. In some cases it is required by regulations protecting the outside environment.

Poorly designed systems are ineffective or inefficient.

Gloves and other protective clothing

(goggles, face shields, aprons)

WHEN IS PROTECTIVE CLOTHING NECESSARY?

Base your evaluation on:

- Actual job conditions (splashing toward eyes or clothing; skin contact occurring; mist, concentrated vapors, or overspray contacting worker; etc.)
- "SKIN" notation. Cal/OSHA designates some solvents with a "Skin" notation as part of the Permissible Exposure Limit. These solvents are absorbed through skin much faster than others. By law, employers must not allow any skin contact with these solvents. See the Solvent Data Table.
- Dermatitis or skin irritation have affected employees
- Warnings on Material Safety Data Sheet

THE EMPLOYER IS RESPONSIBLE

As part of the obligation to provide a safe environment, the employer must:

- Assess hazards and select proper protective clothing
- Purchase and provide equipment to employees
- Train employees in the use of the equipment and in its limitations.
- Make and enforce rules regarding the use of protective clothing.
- Keep written documentation of the hazard assessment and employee training.

SELECTING THE RIGHT MATERIALS

Choose materials that resist the specific solvents you use. Get professional advice from a specialty supplier of safety products. Equipment manufacturers can usually provide information about the material's ability to block various solvents. Also consider dexterity, size, flexibility, cut resistance, cost and other characteristics you may need. Choosing gloves for solvent mixtures can be difficult; you may need to double-glove if no one material proves adequate.

GLOVE PERFORMANCE PROBLEMS

Replace gloves when necessary to maintain effective protection. Gloves are subject to the destructive action of chemicals, as well as ordinary wear and tear. Glove materials eventually soften, crack or weaken due to solvents. The type of glove material and its thickness are both important. Damaged or inappropriate material may absorb solvent and hold it next to the skin, which can be very dangerous. Chemicals penetrate most glove materials much faster than people realize. Train employees to check their gloves frequently.

GLOSSARY OF TERMS FOR GLOVES AND OTHER PROTECTIVE CLOTHING

- Breakthrough time: The time it takes before the solvent can be detected on the inside of the glove. Ask the manufacturer for test results. Usually, a thicker glove has a longer breakthrough time than a thinner glove of the same material.
- Degradation: Physical deterioration of the material (it may soften, become brittle, crack, etc.) due to solvents, other chemicals, heat, or physical stress.
- Penetration: passage of solvent through seams, zippers, pinhole defects in new garments, or tears in used garments.
- Permeation: Liquid or gas solvent passing through intact material (at the molecular level). Permeation can occur without any visible change in the condition of the glove.

Training Tips

WHAT TO COVER
Be sure to cover job-specific work rules and procedures, emergency procedures, and applicable Material Safety Data Sheets. The "Basic safe work methods" section is useful for all solvent workers. Cal/OSHA training requirements are detailed in the Hazard Communication Standard (GISO 5194).

WHEN TO TRAIN
For solvent handlers, you should include safety training with the initial job orientation, then reinforce it regularly. Also train when a new chemical, hazard, or process is introduced.

PEOPLE LEARN BY DOING, NOT JUST BY LISTENING
It's a fact that most people learn best by practicing work tasks, answering questions, participating in emergency response drills, and teaching others. Be sure to include these methods in your trainings.

WHERE TO HOLD THE TRAININGS
The settings for training activities can include classroom, tailgate or on-the-job locations. It depends whether you need a quiet place or if you need to be where the chemicals or equipment are located.

DON'T RELY ON HANDOUTS ALONE
A part of your training can include written materials such as this booklet, or pages copied from this booklet. But no handouts can replace person-to-person communication.

Ten training tips

TIP #1: DEMONSTRATE
Explain and demonstrate safe work methods. Ask a volunteer to demonstrate for the others.

TIP #2: HAVE A DRILL
A fire, spill, accident or first aid drill is a good way to get everyone's attention. Discuss the drill before and after.

TIP #3: ASK QUESTIONS
Questions keep people awake. Give the group time to answer. Don't insist on the one right answer, but add points that were left out by others.

TIP #4: DON'T PUT PEOPLE ON THE SPOT
Don't assume everyone can read easily. It's best to ask for volunteers. Put the group at ease by letting them know you won't call on anyone to read aloud.

TIP #5: TEACH BY EXAMPLE
Demonstrate realistic work methods and be consistent. Don't undo your training by demonstrating dangerous shortcuts after the training.

TIP #6: REPEAT, REPEAT
People forget things they don't use for a while. Combat this tendency by repeating important topics occasionally.

TIP #7: DISCUSS RECENT SAFETY PROBLEMS
Report accidents and near-accidents that have happened in your group or other crews. Discuss possible reasons and corrective actions.

TIP #8: ASK FOR SUGGESTIONS
Invite workers to report safety and health issues they see. Report on actions taken to resolve problems previously discussed.

TIP #9: SIGN-IN SHEET
A sign-in sheet is a record for you and for Cal/OSHA. Write on the sheet the date and the topics discussed. Signatures of attendees prove that they were present.

TIP #10: KEY WORDS HELP
Write new words, abbreviations, and technical words on a blackboard or flip chart. This reinforces learning, and is also helpful for people who don't write well.

THE TRAINING TIPS IN ACTION

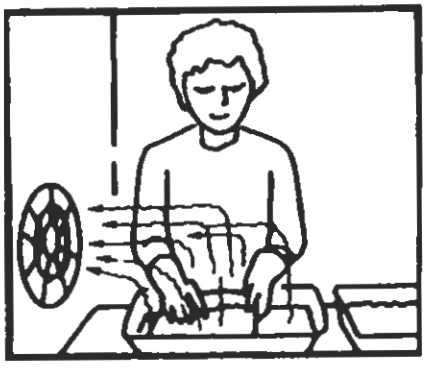
Here is an example of a training session that would be highly effective in communicating health and safety principles and practices for a specific job task involving solvent use:

> "Today we are going to go over the right way to clean printing rollers with blanket wash solvent. This is where we keep the blanket wash. Always use these green gloves and these goggles to prevent skin and eye contact. If any supplies are low, tell Bob R. MSDSs are in this binder here. Who will take down the binder and locate the MSDS for the blanket wash? OK, will you look over the MSDS and tell us, is it flammable? Volatile? Who can tell us what "volatile" means? (Supervisor/instructor reviews major health hazards on MSDS.)
> Let's have someone demonstrate how to clean these rollers (supervisor/instructor makes sure the volunteer is demonstrating safe work methods as well as effective technique for getting the rollers clean). Waste solvent is kept in this drum over here. Always keep it capped. Who can tell us why we don't pour used blanket wash down the drain?
> OK, now who can tell us what to do in case of a solvent spill? ... Any questions?... Now, this is where to put the wet rollers...notice that I'll need a pair of gloves for that..."

This kind of training session will be effective because it includes lots of participation, including activities, questions and answers, and how-to information that employees will find practical.

Respirators: must you use them?

You may be better off using methods other than respirators. Here's why:



Ventilation usually works better than respirators

VENTILATION WORKS BETTER
Respirators are not as effective as ventilation in protecting workers in most situations. That's why Cal/OSHA allows respirators only if ventilation is not technically possible.

RESPIRATORS ARE NOT CHEAP
Costs of equipment, training, fit-testing, replacement cartridges and maintenance continue year after year. The cost of a ventilation system is primarily for installation; most systems only require maintenance once or twice a year.

RESPIRATORS ARE HARD TO WORK IN
Respirators are often uncomfortable and hot, and they can interfere with vision, speech, hearing, or movement.

Dust masks do not work at all for solvent vapors

THEY GIVE A FALSE SENSE OF SECURITY
It is dangerous to use ineffective respirators. Workers may go into dangerous situations, believing they are safe. Cal/OSHA requires that many steps be completed for a legal, effective respirator program.

DON'T DO-IT-YOURSELF
Most firms will need to hire an industrial hygiene consultant to test the air, select respirators, write up the program, fit-test and train the respirator users. The consultant should also train the manager who will be responsible for maintaining the program. Remember, ineffective respirator use is both dangerous and illegal.

Using respirators effectively and legally

SCBA

RELY ON RESPIRATORS FOR FIELD WORK

Usually in a shop or factory, it is possible to ventilate the workroom properly and keep the air safe to breathe. However, for contractors and others who work at field locations, respirators may be the only alternative, unless a solvent-free chemical substitute can be found.

TYPES OF RESPIRATORS

• **Self-contained breathing apparatus (SCBA)** requires the wearer to carry air tanks. It is used in emergencies and other special situations.

• **Supplied air (air-line) respirators** provide very effective protection. An air hose carries outdoor air to the respirator headpiece, using a special oil-free compressor. The worker must stay connected to the hose.

PAPR

• **Powered air-purifying respirators** (PAPR) use an integral fan and filter unit (battery-powered) to supply purified air to the headpiece. Filters are replaceable. Currently, NIOSH has approved only two models of PAPR for organic vapors; be sure to check for approval number TC-14G-122.

• **Cartridge filter respirators** are rubber face masks that use replaceable filter cartridges. The wearer's lungs provide the power to pull air through the filters, so the masks can be tiring to wear for a long time. Effectiveness is limited because contaminated air often leaks around the edges of the mask. Disposable versions of organic vapor filter masks are also sold, but expect even more edge leakage than rubber models.

Cartridge filter respirator (half-face mask style)

OSHA REQUIREMENTS FOR USE OF RESPIRATORS

Cal/OSHA's respirator standard (General Industry Safety Order 5144) describes all the steps required for legal business use of respirators. Here are the main requirements of GISO 5144:

• Train users to understand the uses, limitations and care of their respirators.

• Select respirators that have a TC code. It will say "TC" followed by some number. Only TC-coded respirators are government tested and certified.

• Test the fit of each person's mask. A poorly fitting mask will allow solvent-contaminated air to leak in between the face and the mask. Also teach the user how to do a quick fit check each time he or she puts on the respirator.

• Keep respirators clean and in good repair. Store organic vapor filters in an airtight bag. (A good practice is to store each respirator, with its filters, in a tightly closed plastic bag marked with the user's name.)

• Employees who have a heart or lung condition should consult a doctor to check if it's okay to use a respirator. Wearing a non-powered respirator makes the heart and lungs work harder. People who can't use non-powered filter respirators may be able to use powered air-purifying respirators (PAPR) or airline respirators.

• Assign a person to be responsible for the respirator program.

• Keep written records of how you've met the above requirements.

Organic vapor filter cartridges

FILTER CARTRIDGES ARE NOT SAFE TO USE FOR ALL SOLVENTS

Do not use filter-type respirators for solvents with poor warning properties (for instance, without a strong odor and without the ability to irritate the eyes or nose) . Benzene, for example, should not ordinarily be used with filter-type respirators because workers will not be able to detect respirator failure. Use other types of respirators (such as supplied air respirators). Also, there are some solvents, like methanol, that are not well absorbed by organic vapor cartridges.

REPLACE FILTER CARTRIDGES OFTEN

Organic vapor filter cartridges stop working when their carbon granules become saturated with solvent. Most respirator users need to replace their cartridges more often than they realize. Also, individuals vary in their ability to smell solvents. If solvent odor is detected inside the mask by the wearer at any time, it means that the filters are saturated or that the fit is inadequate. Train workers to correct this situation immediately.

HOW TO PREDICT FILTER LIFE AND REPLACEMENT COSTS

You can estimate filter replacement needs if you have workplace vapor measurements and information from the respirator cartridge manufacturer. Here are some examples of how long filters will last in low-humidity environments:

Chemical Name	Filter Life* at 1000 PPM	PEL**
acetone	37 minutes	750 ppm
ethanol	28 minutes	1000 ppm
toluene	94 minutes	100 ppm
1,1,2-trichloroethane	72 minutes	350 ppm

*approximate effective life (until 1% breakthrough) of typical organic vapor filters when used in air containing 1000 ppm of the solvent listed. Filter life will be shorter if solvent vapor concentration is greater, or longer if the concentration is less.

** Permissible exposure limit set by Cal/OSHA.

You'll have to replace organic vapor filters even more often if:

- humidity is high (over 50% relative humidity)
- several types of solvent vapor are present
- vapor concentration fluctuates.

Permissible Exposure Limits for solvents

PERMISSIBLE EXPOSURE LIMITS (PELS)
PELs are legal exposure limits for airborne contaminants (vapors, dusts, etc.) set forth in the California OSHA (Cal/OSHA) regulations. By law, California employers who use regulated substances must keep air contaminants breathed by employees below the PELs for these substances. Some PELs are listed in the Solvent Data Table at the end of this booklet. Obtain further information about these regulations from Cal/OSHA (see pages 53-54). Cal/OSHA standards are often stricter than federal OSHA standards.

THRESHOLD LIMIT VALUES (TLVs)
TLVs are suggested exposure limits recommended by a self-appointed committee of a private organization, the American Conference of Governmental Industrial Hygienists (ACGIH). The TLV is occasionally different from the PEL. The TLV is not an enforceable standard.

TIME WEIGHTED AVERAGES (TWAs)
Unless otherwise stated, the PEL and TLV are given in terms of the worker's average exposure over an 8-hour work day. The TWA is the average exposure measured over a specified period. Supposedly, most individuals breathing this concentration, eight hours per day, forty hours per week, over a working lifetime, should not experience any health damage.

BRIEF, INTENSE EXPOSURES
Some chemicals have regulations limiting brief but intense exposures. Short-Term Exposure Limits (STELs) limit the exposure as measured over a stated period of 5, 10, 15, or 30 minutes. Ceiling limits are maximums; do not exceed them at any time.

EXPOSURE LIMITS DON'T COME WITH A GUARANTEE

PELs and TLVs do not guarantee safety, but they are useful guidelines. Most are based on industry's ability to easily limit exposure down to that level. They are not designed for complete protection of health; some workers will experience health effects if exposed at the TLV. Also, information on chronic (long-term) health effects is often not available or is ignored when these limits are set. Some health hazards may not have been discovered. Exposure limits do not necessarily assure safety for all workers, since each individual is different. They do provide guides for currently enforceable legal standards.

CARCINOGENS

The PELs and TLVs for most cancer-causing chemicals are set at levels that may cause an excessive cancer risk. The lifetime excess risk can be one in a thousand, or even as high as one in ten. Many authorities recommend that exposure levels for carcinogens be kept as low as possible.

PELS FOR COMBINATIONS OF SOLVENTS

Individual PELs do not provide adequate protection for people who work with multiple solvents simultaneously (on the same work shift), as is common in industry. The central nervous system (brain) effects, irritant effects, or liver and kidney effects of each solvent may add together in the worker's body. Therefore, combined solvent exposure must be below combined PELs. For example, if Solvent A is measured at 75% of its PEL, then Solvent B needs to be less than 25% of its PEL. The total percentages must not exceed 100%. This rule applies to most solvents, because most solvent PELs are set to protect against central nervous system effects. The rule doesn't apply to carcinogens and other extremely toxic solvents, whose PELs are based on their special toxic effects.

INDIVIDUAL DIFFERENCES AND PELs

Some individuals are especially sensitive to the effects of solvents. People with alcoholism, liver disease or heart disease may not be able to tolerate exposures that are even lower than the PEL.

PART THREE: REFERENCE SECTION

What is Cal/OSHA?

Cal/OSHA is the California Division of Occupational Safety and Health. It is a state agency that sets and enforces workplace health and safety regulations. There are local offices in most large cities. Businesses with one or more employees are covered by Cal/OSHA rules.

• AT WORK: Your supervisor, health and safety committee or union representative

• HESIS
(Hazard Evaluation System and Information Service)
For information on the toxic effects of workplace chemicals. HESIS answers questions from California employees, employers, and health care providers. For a list of HESIS publications, see page 64.

850 Marina Bay Parkway
Building P, 3rd Floor
Richmond, CA 94804
(866) 627-1586 (toll free)

• Cal/OSHA Consultation Service (for employers)
For assistance in understanding and following Cal/OSHA regulations and improving health and safety. The Consultation Service does not issue citations.

Fresno:	**(599) 454-1295**
Oakland:	**(510) 622-2891**
Sacramento:	**(916) 263-0704**
San Bernardino:	**(909) 383-4567**
San Diego:	**(619) 767-2060**
San Fernando Valley:	**(818) 901-5754**
Santa Fe Springs:	**(562) 944-9366**

• **Cal/OSHA Compliance** (for employees)
Investigates worker complaints of unsafe conditions and enforces protective laws such as PELs. See your local phone book (in the government section, near the front of the White Pages) under "State Government Offices, Industrial Relations, Occupational Safety and Health". Or call Cal/OSHA headquarters in Oakland (510) 286-7000 and ask for the office nearest you.

• **Labor Occupational Health Program (LOHP)**
For training and technical assistance to employees, labor unions, and others in Northern California.
Labor Occupational Health Program
University of California, Berkeley
Mail Code 5120
2515 Channing Way, Second Floor
Berkeley, CA 94720
(510) 642-5507

• **Labor Occupational Safety and Health Program (LOSH)**
For training and technical assistance to employees, labor unions, and others in Southern California.
Labor Occupational Safety and Health Program
University of California at Los Angeles
1001 Gayley Avenue, 2nd floor
Los Angeles, CA 90024-1478
(310) 794- 5964

• **Occupational Medicine Clinics and Doctors**
These are specialists in health problems related to workplace hazards. For a referral to a provider in your area, contact:
Association of Occupational and Environmental Clinics
1010 Vermont Street #513
Washington, D.C. 20005
(202) 347-4976

Solvent Data Table

EXPLANATION OF COLUMN HEADINGS

SOLVENT NAME AND SYNONYMS: Full entries are in bold type. Entries that are not bold refer you from a synonym to a full entry.

CAS NUMBER: an identification number assigned to each chemical. The hyphens in the numbers are sometimes left out.

FIRE HAZARD: Numbers in parentheses are the NFPA fire rating:
- (0) not flammable: will not burn
- (1) combustible liquid: able to catch fire if heated over 100 degrees F.
- (2) flammable liquid: can catch fire at ordinary room temperatures (100 degrees F. or less)
- (3) highly flammable
- (4) explosive

VOLATILITY RATING: Describes how quickly a liquid solvent will evaporate (how quickly it goes into the air as a vapor). The ratings are based on vapor pressure in millimeters of mercury (mmHg) at a warm room temperature (77 degrees F):

•Less than 1 mmHg:	VERY LOW
•1-10 mmHg:	LOW
•10-100 mmHg:	MEDIUM
•100-760 mmHg:	HIGH
•More than 760 mmHg:	Gas at room temperature.

One mmHg is very roughly equal to 1300 ppm at normal temperature and pressure.

LEGAL EXPOSURE LIMITS: These are Cal/OSHA's Permissible Exposure Limits; they are legal requirements. The "SKIN" notation means that skin contact must be prevented.

RECOMMENDED EXPOSURE LIMITS: Several organizations recommend voluntary standards for occupational exposures. Standards that are lower (more protective) than the OSHA PEL are listed here. Standards used in this table are:
•NIOSH: National Institute for Occupational Safety and Health (a federal government agency)
•HBEL: Health Based Exposure Levels recommended by the Health-Based Exposure Guidelines Committee (associated with the Santa Clara Center for Occupational Safety and Health)
•TLV: Threshold Limit Values recommended by the American Congress of Governmental Industrial Hygienists (ACGIH)

ODOR THRESHOLD: The smallest amount that most people can smell. Individuals vary greatly in the ability to detect solvents, so the odor threshold is given as a range. If the threshold is greater than the PEL, you could be overexposed without a warning odor. If the threshold is smaller than the PEL, you may smell the odor yet not be overexposed.

OVERALL TOXICITY RATING: Rates how poisonous the solvent is; this rating includes both immediate and long-term health effects.

SPECIAL HEALTH HAZARDS / OTHER INFORMATION: Unusual or special hazards to health. Because almost every solvent can cause dermatitis and affect the brain (central nervous system), these effects are not included in the table.

SPECIAL RESPIRATOR NOTES: Some limitations and warnings about using respirators for the solvent. Always get expert advice when selecting and using respirators.

Solvent Name and Synonyms	CAS Number	Fire Hazard	Volatility	Legal Exposure Limits (Cal/OSHA)	Recommended Exposure Limits	Odor Threshold	Overall Toxicity Rating	Special Health Hazards / Other Information	Special Respirator Notes
acetamide	60-35-5	combustible	VERY LOW	no PEL	HBEL 0.00026 mg/m3		Extremely toxic	Causes cancer in animals. Damages liver. High acute toxicity. Easily absorbed through skin.	
acetone	67-64-1	flammable	HIGH 234 mmHg	750 ppm 8-hr TWA 1000 ppm STEL-15 3000 ppm ceiling	NIOSH 250 ppm HBEL 7 mg/m3	15-150 ppm	Not very toxic	Acetone is less toxic than most other solvents.	
acetonitrile	75-05-8	flammable	MEDIUM 90 mmHg	40 ppm 8-hr TWA 60 ppm STEL SKIN	NIOSH 20 ppm HBEL 0.17 mg/m3	170-1700 ppm	Highly toxic	Easily absorbed through skin. Forms cyanide in the body, causing oxygen deprivation, convulsions, respiratory paralysis, and death.	
acetylene tetrachloride, see 1,1,2,2-tetrachloroethane									
benzene	71-43-2	flammable	MEDIUM 97 mmHg	1 ppm, 8-hr TWA 5 ppm STEL-15 SKIN	NIOSH 0.1 ppm 1 ppm STEL Carcinogen HBEL 0.00006 mg/m3	12-120 ppm	Extremely toxic	Causes cancer (leukemia and probably other kinds) in humans. Causes serious anemia. Easily absorbed through skin.	Not suitable for use with filter-type respirators due to inadequate warning properties.
benzol, see benzene									
benzyl alcohol	100-51-6	combustible	VERY LOW 0.1 mmHg	no PEL	HBEL 3.2 mg/m3		Moderately toxic	Irritant. Easily absorbed through the skin.	
2-butanone, see methyl ethyl ketone									
n-butyl acetate	123-86-4	flammable	MEDIUM 13 mmHg	150 ppm 200 ppm STEL	Proposed TLV 20 ppm	0.4-4 ppm	Not very toxic	Irritant	
n-butyl alcohol	71-36-3	flammable	LOW-MEDIUM	50 ppm ceiling limit SKIN	HBEL 1.1 mg/m3	0.8-8 ppm	Not very toxic	Irritant	
carbon disulfide	75-15-0	flammable	HIGH 366 mmHg	4 ppm 8-hr TWA 12 ppm STEL-15 30 ppm ceiling SKIN	NIOSH 1 ppm TWA 10 ppm STEL HBEL 0.11 mg/m3	0.1-1 ppm; pure forms have less odor	Extremely toxic	Causes mental illness, brain disease, and nerve damage. Can worsen coronary heart disease and cause heart arrhythmias. The liquid is a severe irritant of the skin and eyes. Possible reproductive hazard. Easily skin absorbed.	Not suitable for use with filter-type respirators due to inadequate warning properties.
carbon tetrachloride	56-23-5	will not burn	HIGH 116 mmHg	2 ppm 8-hr TWA 200 ppm ceiling SKIN	NIOSH 2 ppm STEL HBEL 0.00035 mg/m3	100-1000 ppm	Extremely toxic	Causes cancer in animals. Damages liver and kidneys. Easily absorbed through skin. Harmful to ozone layer in the upper atmosphere.	
Cellosolve, see 2-ethoxyethanol									
chlorodifluoromethane (FC-22)	75-45-6	will not burn	Gas at room temp	1000 ppm 8-hr TWA	NIOSH STEL 1250 ppm	nearly odorless	Not very toxic	Extremely high vapor concentrations can cause heart palpitations and heart failure at the time of exposure. Weak evidence for causing cancer in animals. Harmful to ozone layer in the upper atmosphere.	Not suitable for use with filter-type respirators due to inadequate warning properties.
chloroform	67-66-3	will not burn	HIGH 199 mmHg	2 ppm 8-hr TWA	NIOSH STEL 2 ppm HBEL 0.00023 mg/m3	100-1000 ppm	Extremely toxic	Causes cancer in animals and probably humans. Damages liver and kidneys. Extremely high vapor concentrations can cause heart failure. Reproductive hazard.	Not suitable for use with filter-type respirators due to inadequate warning properties.
chloromethane, see methyl chloride									

Solvent Data Table

Solvent Name and Synonyms	CAS Number	Fire Hazard	Volatility	Legal Exposure Limits (Cal/OSHA)	Recommended Exposure Limit	Odor Threshold	Overall Toxicity Rating	Special Health Hazards / Other Information	Special Respirator Notes
cyclohexane	110-82-7	flammable	MEDIUM 99 mmHg	300 ppm 8-hr TWA		25-250 ppm	Not very toxic	irritant.	
cyclohexanone	108-94-1	flammable	LOW 4 mmHg	25 ppm 8-hr TWA SKIN	HBEL 7 mg/m3	1-10 ppm	Not very toxic	Irritant. Easily absorbed through skin.	
dichlorodifluoromethane (FC 12)	75-71-8	will not burn	Gas at room temp	1000 ppm 8-hr TWA 6200 ppm ceiling	HBEL 0.69 mg/m3		Not very toxic	Extremely high concentrations can cause heart palpitations and heart failure at the time of exposure.	Not suitable for use with filter-type respirators due to inadequate warning properties.
1,1-dichloroethane (ethylidene chloride)	75-34-3	very flammable	HIGH 232 mmHg	100 ppm 8-hr TWA	NIOSH potential carcin, 100 ppm. HBEL 0.0032 mg/m3		Moderately toxic	Damages kidneys and liver at very high exposure levels. Suspect cancer-causing agent, based on weak information.	
1,2-dichloroethane (ethylene dichloride)	107-06-2	flammable	MEDIUM 81 mmHg	1 ppm 8-hr TWA 2 ppm STEL 200 ppm ceiling	HBEL 0.0002 mg/m3	88-880 ppm	Extremely toxic	Causes cancer in animals.	
1,1-dichloroethylene, see vinylidene chloride									
1,2-dichloroethylene (DCE)	540-59-0	flammable	HIGH 198-334 mmHg	200 ppm 8-hr TWA	HBEL 0.11 mg/m3	17-170 ppm	Moderately toxic	Very high exposures can damage the liver, lungs, and heart.	
dichlorofluoromethane (FC 21)	75-43-4	will not burn		10 ppm 8-hr TWA			Highly toxic	Liver damage. Possible hazard to pregnancy at very high exposure levels. Harmful to ozone in the upper atmosphere.	
dichloromethane, see methylene chloride									
1,2-dichlorotetrafluoroethane (FC 114)	76-14-2	will not burn	Gas at room temp	1000 ppm 8-hr TWA			Not very toxic	Extremely high concentrations can cause heart palpitations and heart failure at the time of exposure.	Not suitable for use with filter-type respirators due to inadequate warning properties.
diethylene glycol butyl ether (DEGBE)	112-34-5	combustible	Very low <0.2 mmHg	no PEL			Not very toxic	DEGBE does not have the reproductive toxic hazards that some other glycol ethers do.	
diethylene glycol dibutyl ether (DEGDBE)	112-73-2	combustible	Very low <0.4 mmHg	no PEL			Not very toxic	DEGDBE does not have the reproductive toxic hazards that some other glycol ethers do.	
diethylene glycol diethyl ether (DEGDEE)	112-36-7		Very low 0.4 mmHg	5 ppm 8-hr TWA SKIN			Highly toxic	This is a glycol ether that is a reproductive toxin. Easily absorbed through skin.	
diethylene glycol dimethyl ethe (diglyme; DEGDME)	111-96-6	combustible	Low 2.4 mmHg	1ppm 8-hr TWA SKIN			Extremely toxic	This is a glycol ether that is a reproductive toxin. Easily absorbed through skin.	
diethylene glycol ethyl ether (DEGEE)	111-90-0	combustible	Very low 0.13 mmHg	no PEL				It is not known whether DEGEE has the reproductive toxic hazards that some other glycol ethers do.	
diethylene glycol methyl ether (DEGME)	111-77-3	combustible	Very low 0.18 mmHg	no PEL				It is likely that DEGME has some of the reproductive toxic hazards that some other glycol ethers do.	

Solvent Data Table

Solvent Name and Synonyms	CAS Number	Fire Hazard	Volatility	Legal Exposure Limits (Cal/OSHA)	Recommended Exposure Limit	Odor Threshold	Overall Toxicity Rating	Special Health Hazards / Other Information	Special Respirator Notes
diethyl ether, see ethyl ether									
diglyme, see diethylene glycol dimethyl ether									
dimethyl acetamide (DMAC)	127-19-5	combustible	Very low 0.56 mmHg	10 ppm 8-hr TWA SKIN		50-500 ppm	Highly toxic	Can damage liver. Can cause birth defects or fetal loss in animals. May damage testicles. Skin absorption is extremely high!	
dimethyl benzene, see xylene									
dimethylformamide (DMF)	68-12-2	combustible	LOW 3 mmHg	10 ppm 8-hr TWA SKIN	HBEL 0.10 mg/m3	2-20 ppm	Highly toxic	Can damage liver. Nausea, vomiting and abdominal pain are symptoms of overexposure. May damage kidneys. Causes birth defects in animals. Suggested possible cause of testicular cancer. Extremely easily absorbed through skin as a liquid or vapor.	
n,n-dimethyl formic acid, see dimethylformamide									
dimethyl ketone, see acetone									
DMF, see dimethylformamide									
dioxane (1,4-dioxane)	123-91-1	flammable	MEDIUM 37 mmHg	25 ppm 8-hr TWA SKIN	NIOSH 1 ppm/ 30 minutes HBEL 0.0017 mg/m3	25-250 ppm	Extremely toxic	Causes cancer in animals. Toxic to liver and kidneys. Easily absorbed through skin, causing poisoning without any warning signs.	Not suitable for use with filter-type respirators due to inadequate warning properties.
dioxolane	646-06-0	flammable	HIGH 110 mmHg	no PEL			Not very toxic	Irritant.	
1,2-ethanediol, see ethylene glycol									
ethanol	64-17-5	flammable	MEDIUM 58 mmHg	1000 ppm 8-hr TWA		85-850 ppm	Not very toxic	Vapors are not very toxic, but are irritating. Industrial ethanol is often "denatured" (by adding methanol or other toxic substances) in order to prevent people from drinking it. Denatured alcohol is often labeled "SD Alcohol".	
2-ethoxyethanol	110-80-5	combustible	LOW 5 mmHg	5 ppm 8-hr TWA SKIN	NIOSH 0.5 ppm SKIN HBEL 0.7 mg/m3	3-30 ppm	Extremely toxic	This solvent is a glycol ether. Causes birth defects and testicular damage in animals. Damages blood cells and bone marrow. Easily absorbed through skin.	Not suitable for use with filter-type respirators due to inadequate warning properties.
ethyl acetate	141-78-6	flammable	MEDIUM 95 mmHg	400 ppm 8-hr TWA	HBEL 9.6 mg/m3	4-40 ppm	Not very toxic	Irritant.	
ethyl alcohol, see ethanol									
ethyl benzene	100-41-4	flammable	LOW 9.6 mmHg	100 ppm 8-hr TWA 125 ppm STEL	HBEL 3.4 mg/m3	2-20 ppm	Moderately toxic	Irritant. Weak evidence for cancer-causing ability. Weak reproductive hazard. Easily absorbed through skin.	
ethylene dichloride, see 1,2-dichloroethane									
ethylene glycol	107-21-1	can burn if heated	VERY LOW 0.075 mmHg	50 ppm ceiling	(NIOSH says 50 ppm is not protective) HBEL 21.3 mg/m3		Moderately toxic	Damages kidneys (when ingested). Very high exposures cause birth defects in animals. Vapor exposures are usually too low to be harmful.	

Solvent Name and Synonyms	CAS Number	Fire Hazard	Volatility	Legal Exposure Limits (Cal/OSHA)	Recommended Exposure Limit	Odor Threshold	Overall Toxicity Rating	Special Health Hazards / Other Information	Special Respirator Notes
ethylene glycol butyl ether (EGBE)	111-76-2	combustible	LOW 1.1 mmHg	25 ppm 8-hr TWA SKIN	NIOSH 5 ppm HBEL 0.069 mg/m3	0.1-1 ppm	Moderately toxic	This solvent is a glycol ether. Damages blood cells, but does not have the reproductive toxic hazards that some other glycol ethers do. Easily absorbed through skin.	
ethylene glycol diethyl ether (EGDEE)	629-14-1		LOW-MED 10 mmHg	5 ppm 8-hr TWA SKIN			Highly toxic	This solvent is a glycol ether and a reproductive toxin.	
ethylene glycol dimethyl ether (EGDME)	110-71-4	moderate fire risk	MEDIUM 75 mmHg	1 ppm 8-hr TWA SKIN			Extremely toxic	This solvent is a glycol ether. Causes birth defects and testicular damage in animals. Easily absorbed through skin.	
ethylene glycol monoethyl ether, see 2-ethoxyethanol									
ethylene glycol monomethyl ether, see 2-methoxyethanol									
ethyl ether (diethyl ether)	60-29-7	very flammable; explosive if distilled to dryness	HIGH 538 mmHg	400 ppm 8-hr TWA 500 ppm STEL-15	(NIOSH says the PEL is not protective) HBEL 2.1 mg/m3	9-90 ppm	Not very toxic	Irritant. Discontinued use as anesthetic gas mainly because of explosive hazard and risk of death at anesthetic levels.	
FC-11, see trichlorofluoromethane									
FC-12, see dichlorodifluoromethane									
FC-22, see dichlorodifluoromethane									
FC-113, see 1,1,2-trichloro-1,2,2-trifluoroethane									
FC-114, see 1,2-dichlorotetrafluoroethane									
fluorocarbons (Freons®; a group of related solvents and solvent mixtures)		will not burn	Most are gases at room temp	varies from 10 ppm to 1000 ppm, 8-hr TWA		varies, depending which type of fluorocarbon	Varies (most are of low toxicity)	See individual entries. Severe overexposure to fluorocarbon vapors can cause heart palpitations and heart failure at the time of exposure. Many are harmful to ozone layer in the upper atmosphere.	Unsuitable for use with filter-type respirators due to inadequate warning properties.
formamide	75-12-7	combustible	Very low	10 ppm 8-hr TWA SKIN		nearly odorless	Highly toxic	Birth defects in animals. Liver damage.	
furfural	98-01-1	combustible	Low 2.2 mmHg	2 ppm 8-hr TWA SKIN	(NIOSH says the PEL is not protective) HBEL 0.07 mg/m3	0.1-1 ppm	Extremely toxic	Can damage liver. Some evidence of cancer in animals. Easily absorbed through skin.	
gasoline	8006-61-9	flammable	MEDIUM to HIGH 38-300 mmHg	300 ppm 8-hr TWA 500 ppm STEL-15			Moderately toxic	Often contains benzene (see above) and other highly toxic substances such as organic lead. Causes cancer in rats but possibly not in humans.	
grain alcohol, see ethanol									
heptane (n-heptane)	142-82-5	flammable	MEDIUM 46 mmHg	400 ppm 8-hr TWA 500 ppm STEL	NIOSH 85 ppm 440 ppm STEL-15	150-1500 ppm	Not very toxic	Good substitute for hexane.	
hexachlorobutadiene	87-68-3	non-flammable	VERY LOW	0.02 ppm 8-hr TWA SKIN			Extremely toxic	Causes cancer in animals. Easily absorbed through skin.	

Solvent Name and Synonyms	CAS Number	Fire Hazard	Volatility	Legal Exposure Limits (Cal/OSHA)	Recommended Exposure Limit	Odor Threshold	Overall Toxicity Rating	Special Health Hazards / Other Information	Special Respirator Notes
hexamethylene, see cyclohexane									
hexane (except for n-hexane)		flammable	HIGH 152 mmHg	500 ppm 8-hr TWA 1000 ppm STEL-15	NIOSH 100 ppm; 510 ppm for 15 min.	130-1300 ppm	Not very toxic	Hexane is a mixture of several molecular forms. It often contains n-hexane.	
n-hexane (a type of hexane)	110-54-3	flammable	HIGH 152 mmHg	50 ppm 8-hr TWA	HBEL 0.69 mg/m3	130-1300 ppm	Highly toxic	Causes peripheral neuropathy (nerve damage in the legs and arms).	Unsuitable for use with filter-type respirators due to inadequate warning properties.
2-hexanone, see methyl n-butyl ketone									
High Flash Naphtha, see Stoddard Solvent									
isopropanol, see isopropyl alcohol									
isopropyl alcohol	67-63-0	flammable	MEDIUM 46 mmHg	400 ppm, 8-hr TWA 500 ppm STEL		22-220 ppm	Not very toxic	Irritant	
d-limonene	5989-27-5	combustible	LOW 1.9 mmHg	no PEL	30 ppm 8-hr TWA (AIHA)	1 ppb (0.001 ppm)	Moderately toxic	Can cause allergic contact dermatitis in a large proportion of users. Can damage the liver. Causes cancer in rats but probably not in humans. **Easily absorbed through skin.**	
MEK, see methyl ethyl ketone									
methanol	67-56-1	flammable	HIGH 128 mmHg	200 ppm 8-hr TWA 250 ppm STEL-15 1000 ppm ceiling SKIN	HBEL 5.3 mg/m3	100-1000 ppm	Moderately toxic	**Can cause blindness or death if swallowed.** (Breathing vapors and skin absorption are not likely to cause blindness.) Absorbed easily through the skin.	Organic vapor respirator cartridges (charcoal) are NOT effective; also has inadequate warning properties.
2-methoxyethanol (methyl Cellosolve; EGME)	109-86-4	combustible	LOW-MED 9.8 mmHg	5 ppm 8-hr TWA SKIN	NIOSH 0.1 ppm SKIN HBEL 0.07 mg/m3	2.3-23 ppm	Extremely toxic	**This solvent is a glycol ether.** Causes birth defects **and testicular damage in animals. Damages blood cells and bone marrow.** Easily absorbed through **skin.**	Unsuitable for use with filter-type respirators due to inadequate warning properties.
methyl acetate	79-20-9	flammable	HIGH 219 mmHg	200 ppm 8-hr TWA 250 ppm STEL-15	HBEL 10.7 mg/m3	5-50 ppm	Not very toxic	*Irritant.* **Extremely high levels** can damage optic nerve (eyes).	
methyl acetic ester, see methyl acetate									
methyl alcohol, see methanol									
methyl benzene, see toluene									
methyl Cellosolve, see 2-methoxyethanol									
methyl chloride	74-87-3	flammable	Gas at room temp	5 ppm 8-hr TWA 100 ppm STEL-15 300 ppm ceiling	NIOSH carcin; lowest feasible exposure. HBEL 0.0029 mg/m3		Extremely toxic	Reproductive hazard. Possible carcinogen. Strong effects on brain. Symptoms can be delayed for several hours after exposure. Easily absorbed through skin.	Organic vapor respirator cartridges (charcoal) are NOT effective for methyl chloride.

Solvent Data Table

Solvent Name and Synonyms	CAS Number	Fire Hazard	Volatility	Legal Exposure Limits (Cal/OSHA)	Recommended Exposure Limit	Odor Threshold	Overall Toxicity Rating	Special Health Hazards / Other Information	Special Respirator Notes
methyl chloroform, see 1,1,1-trichloroethane									
methylene chloride	75-09-2	will not burn	HIGH 442 mmHg	50 ppm 8-hr TWA	NIOSH carcinogen; lowest feasible exposure. HBEL 0.011 mg/m3	250-2500 ppm	Highly toxic	Causes cancer in animals; suspected of causing cancer in humans. Changes to carbon monoxide in the body. Can aggravate pre-existing heart disease. Easily absorbed through skin.	Unsuitable for use with filter-type respirators due to inadequate warning properties.
methyl ethyl ketone	78-93-3	flammable	MEDIUM 96 mmHg	200 ppm 8-hr TWA 300 ppm STEL-15	HBEL 3.4 mg/m3	5.5-55 ppm	Not very toxic	Makes n-hexane and methy n-butyl ketone more able to cause nerve damage.	
methyl isobutyl ketone (MIBK; hexone)	108-10-1	flammable	MEDIUM 20 mmHg	50 ppm 8-hr TWA 75 ppm STEL	HBEL 0.28 mg/m3	0.7-7 ppm	Not very toxic		
methyl n-butyl ketone (methyl butyl ketone; MBK; 2-hexanon	591-78-6	flammable	MEDIUM 12 mmHg	5 ppm 8-hr TWA SKIN	NIOSH 1 ppm	0.08-0.8 ppm	Extremely toxic	Can cause nerve damage to the arms and legs (peripheral neuropathy). Easily absorbed through skin.	
N-methyl formamide (NMF)	123-39-7		VERY LOW	no PEL			Highly toxic	Can damage liver. Easily absorbed through skin.	
N-methyl pyrrolidone (NMP)	872-50-4	combustible	VERY LOW 0.3 mmHg	no PEL			Moderately toxic	Causes birth defects in animals. Easily absorbed through skin. May cause miscarriage if absorbed during pregnancy.	
mineral spirits, see Stoddard Solvent									
morpholine	110-91-8	flammable	LOW-MED 10 mmHg	20 ppm 8-hr TWA 30 ppm STEL-15 SKIN		0.01-0.10 ppm	Highly toxic	Strong irritant. High exposures can damage the lungs, liver, and kidney. Possible carcinogen. Easily absorbed through skin.	
naphtha, coal tar (not petroleum naphtha)	8030-31-7	combustible	LOW <5 mmHg	100 ppm 8-hr TWA			Moderately toxic		
2-nitropropane	79-46-9	flammable	MEDIUM 17 mmHg	10 ppm 8-hr TWA	NIOSH carcinogen; lowest feasible exposure	70-700 ppm	Extremely toxic	Affects kidneys and liver. Causes cancer in animals.	
p-dioxane, see dioxane									
pentane (n-pentane)	109-66-0	very flammable	HIGH 519 mmHg	600 ppm 8-hr TWA 750 STEL-15	NIOSH 120 ppm; 610 ppm STEL-15	400-4000 ppm	Not very toxic		
perc, see perchloroethylene									
perchloroethylene (perc; tetrachloroethylene)	127-18-4	will not burn	MEDIUM 18 mmHg	25 ppm 8-hr TWA 300 ppm ceiling	NIOSH carcin; lowest feasible exposure. HBEL 0.01 mg/m3	27-270 ppm	Highly toxic	Damages liver, kidneys. Causes cancer in animals.	
petroleum naphtha, see VM&P naphtha									
phenol	108-95-2	combustible	VERY LOW 0.4 mmHg	5 ppm 8-hr TWA SKIN	NIOSH ceiling 15.6 ppm 15 min. HBEL 6.4 mg/m3	0.04-0.4 ppm	Extremely toxic	Death or serious illness can occur after skin absorption with no warning properties. Easily absorbed through skin, even as a vapor. Can cause burns.	
2-propanol, see isopropyl alcohol									
2-propanone, see acetone									
propylene glycol (propanediol)	57-55-6	combustible	VERY LOW 0.2 mmHg	no PEL	HBEL 20.7 mg/m3		Not very toxic	Very low toxicity.	

Solvent Data Table

Solvent Name and Synonyms	CAS Number	Fire Hazard	Volatility	Legal Exposure Limits (Cal/OSHA)	Recommended Exposure Limit	Odor Threshold	Overall Toxicity Rating	Special Health Hazards / Other Information	Special Respirator Notes
propylene glycol methyl ether (PGME)	107-98-2	flammable	LOW-MED 10.7 mmHg	100 ppm, 8-hr TWA 150 ppm STEL		10-100 ppm	Not very toxic	Does not have the same kind of toxicity as some other glycol ether solvents.	
Rubber Solvent (naphtha)	8030-30-6	combustible	LOW	400 ppm 8-hr TWA			Not very toxic		
Stoddard Solvent (high flash naphtha)	8052-41-3	combustible		100 ppm 8-hr TWA	NIOSH 67 ppm	1-10 ppm	Moderately toxic	This is a mixture of solvents. It may contain benzene.	
styrene	100-42-5	flammable	LOW 6 mmHg	50 ppm 8-hr TWA 100 ppm STEL-15 500 ppm ceiling SKIN	HBEL 0.0092 mg/m3	0.3-3 ppm	Moderately toxic	Suspected of causing cancer in animals. May damage liver, kidneys. Easily absorbed through the skin.	Not suitable for use with filter-type respirators due to inadequate warning properties.
TCA, see 1,1,1-trichloroethane									
1,1,2,2-tetrachloroethane	79-34-5	will not burn	LOW 5 mmHg	1 ppm 8-hr TWA SKIN	NIOSH carcinogen: minimize exposure. HBEL 0.000067 mg/m3	1.5-15 ppm	Extremely toxic	Toxic to liver; may cause hepatitis. Suspected carcinogen. Can cause kidney damage. Possible reproductive hazard. Easily absorbed through skin.	
tetrachloroethylene, see perchloroethylene									
tetrachloromethane, see carbon tetrachloride									
tetrahydrofuran (THF)	109-99-9	flammable	HIGH 164 mmHg	200 ppm 8-hr TWA 25 ppm STEL		2-20 ppm	Not very toxic	Irritant.	
toluene	108-88-3	flammable	MEDIUM 29 mmHg	50 ppm 8-hr TWA 150 STEL-15 500 ppm ceiling SKIN	HBEL 21.3 mg/m3	3-30 ppm	Moderately toxic	Toluene can cause addiction. Sniffing can be fatal. Sniffing during pregnancy can cause birth defects. Easily absorbed through skin. Very rarely, can cause nerve damage to the arms and legs (peripheral neuropathy). May damage kidneys and liver.	
toluol, see toluene									
1,1,1-trichloroethane (methyl chloroform)	71-55-6	will not burn	HIGH 124 mmHg	350 ppm 8-hr TWA 450 ppm STEL-15 800 ppm ceiling	NIOSH 350 ppm ceiling 15 min. HBEL 3.45 mg/m3	120-1200 ppm	Not very toxic	Can cause nerve damage to the arms and legs (peripheral neuropathy), but this is very rare. Harmful to ozone layer in the upper atmosphere.	
1,1,2-trichloroethane	79-00-5	will not burn	MEDIUM 24 mmHg	10 ppm 8-hr TWA SKIN	NIOSH carcin: minimize exposure. HBEL 0.00033 mg/m3		Highly toxic		
trichloroethylene	79-01-6	will burn if heated	MEDIUM 75 mmHg	25 ppm 8-hr TWA 200 ppm STEL-15 300 ppm ceiling	NIOSH carcin: minimize exposure. HBEL 0.0031 mg/m3	28-280 ppm	Highly toxic	Damages liver and kidneys. Causes liver and kidney cancers in animals. Can cause nerve damage (trigeminal neuropathy, affecting the facial muscles, and possibly affecting the senses of taste and smell).	
trichlorofluoromethane (FC 11)	75-69-4	will not burn	Gas at room temp	1000 ppm ceiling	HBEL 2.4 mg/m3	5-50 ppm	Not very toxic	Harmful to ozone layer in the upper atmosphere.	
trichloromethane, see chloroform									

Solvent Name and Synonyms	CAS Number	Fire Hazard	Volatility	Legal Exposure Limits (Cal/OSHA)	Recommended Exposure Limit	Odor Threshold	Overall Toxicity Rating	Special Health Hazards / Other Information	Special Respirator Notes
1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113)	76-13-1	will not burn	HIGH 369 mmHg	1000 ppm 8-hr TWA 1250 ppm STEL-30 2000 ppm ceiling	HBEL 93.1 mg/m3	45-450 ppm	Not very toxic	Extremely high vapor concentrations can cause heart palpitations and heart failure at the time of exposure. Harmful to ozone layer in the upper atmosphere.	Not suitable for use with filter-type respirators due to inadequate warning properties.
triethylene glycol dimethyl ethe (TEGDME)	112-49-2		VERY LOW 0.9 mmHg	5 ppm 8-hr TWA Skin			Highly toxic	This is a glycol ether and a reproductive toxin.	
vinylidene chloride	75-35-4	flammable	HIGH 608 mmHg	1 ppm 8-hr TWA	NIOSH carcinogen: minimize exposure HBEL 0.00011 mg/m3	190-1900 ppm	Extremely toxic	Causes liver and kidney damage; suspected carcinogen.	
vinyl trichleride, see 1,1,2-trichloroethane									
VM&P Naphtha	8032-32-4	flammable	MEDIUM	300 ppm 8-hr TWA 400 ppm STEL-15	NIOSH: approx 85 ppm; Ceiling approx 440 ppm		Not very toxic		
wood alcohol (wood spirit), see methanol									
xylene (a mixture of o-xylene, m xylene, and p-xylene)	1330-20-7 95-47-6 108-38-3 106-42-3	flammable	LOW 6.6-9.6 mmHg	100 ppm 8-hr TWA 150 ppm STEL-15 300 ppm ceiling	HBEL 2.1 mg/m3	1-10 ppm	Moderately toxic	May damage kidneys, liver, gastrointestinal tract, and cornea of the eye. Easily absorbed through skin.	

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FACT SHEETS are 4-6 page summaries of health effects and safe ways to use common chemicals. They are written for workers, employers, and others without formal scientific or medical training.

_____ Epoxy Resin Systems
_____ Fluorocarbons (Freons®)
_____ Glutaraldehyde
_____ Isocyanates
_____ Mercury
_____ Methyl Methacrylate
_____ PCBs
_____ Styrene
_____ Toluene
_____ Xylene
_____ Ethylene Oxide
_____ Formaldehyde (Spanish_____)
_____ Glycol Ethers
_____ Lead (Spanish_____)
_____ Methyl Bromide (Spanish_____)
_____ Methylene Chloride (Spanish___)
_____ Perchloroethylene (Korean____)
_____ 1,1,1-Trichloroethane
_____ Tuberculosis
_____ If I'm Pregnant, Can the Chemicals I Work With Harm My Baby?
_____ Evaluating Workplace Hazards to Pregnancy: Roles of the Employer and Personal Physician
_____ Hepatitis B Vaccination and the Cal/OSHA Bloodborne Pathogens Standard
_____ Wood Preservatives containing Arsenic and Chromates
_____ Pulmonary Function Testing (Spanish_____)

HAZARD ALERTS are summaries similar to HESIS Fact Sheets. They are issued when a new or previously unrecognized hazard is first identified. Later, they may be replaced by Fact Sheets.

_____ Chromium-6 (graphics version, with three industry-specific inserts)
_____ Chromium-6 (technical version)
_____ Cycloheximide
_____ Ribavirin

>>>>>>>>>>>>>>>>>>>continued on next page>>>>>>>>>>>>>>>>>>>>>>

BOOKLETS are written for workers, employers, and others without formal scientific or medical training. They are more comprehensive than Fact Sheets.

_____ Understanding Toxic Substances: An Introduction to Chemical Hazards in the Workplace
_____ Workplace Chemical Hazards to Reproductive Health: A Resource for Worker Health and Safety Training and Patient Education
_____ HESIS Guide to Solvent Safety
_____ Lead in the Workplace: A Guide for Employers and Health & Safety Trainers
_____ HESIS Guide to Metalworking Fluids (accompanied by an illustrated informational flier)
_____ Polish Up Your Jewelry Shop: A Guide for Employees
_____ Photography and Your Health: A Guide to Chemical Hazards in the Darkroom
_____ Artificial Fingernail Products: A Guide to Chemical Exposures in the Nail Salon
_____ Your Hands and Wrists at Work: Carpal Tunnel Syndrome, a Preventable Disease

TECHNICAL DOCUMENTS are scientific documentation for Hazard Alerts and selected other chemicals. They are highly technical.

_____ Reproductive and Hematopoietic Toxicity of the Glycol Ethers: An Update, With Emphasis on Derivative Compounds (1989)

MEDICAL GUIDELINES are brief advisory protocols for diagnosing and managing industrial poisonings when a specific antidote or other specific therapy is available. They are written for health care professionals.

_____ Arsenic
_____ Carbon Monoxide
_____ Cyanide
_____ Hydrogen Sulfide
_____ Mercury
_____ Organophosphates and Carbamates
_____ Lead

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First Aid for Solvent Accidents

Liquid in the eyes:
Immediately wash the solvent out with clean water for at least 10 to 15 minutes. Hold the eyelids open for effective cleaning.

Swallowed liquid:
Do NOT make the person vomit. Call an ambulance or poison control center.

Dizzy, sick or difficulty breathing (from breathing vapors):
Move the person out to fresh air. If he or she doesn't recover immediately, call a doctor. Give artificial respiration if breathing stops. Don't allow a solvent-intoxicated person to drive or to operate machinery.

Liquid on the skin or clothing:
Wipe or wash the solvent product off the skin, using soap and water. Change to clean clothing. A brief skin contact is generally not a problem, but wearing solvent-soaked clothing can be very dangerous.

IF MEDICAL TREATMENT FOLLOWS:
For all solvent accidents, find out what the product is (get the MSDS) to show to medical staff. A physician treating a patient has the right to receive information on trade secret ingredients from the product manufacturer (by calling the emergency phone number on the MSDS).

CALL 911 IN EMERGENCIES